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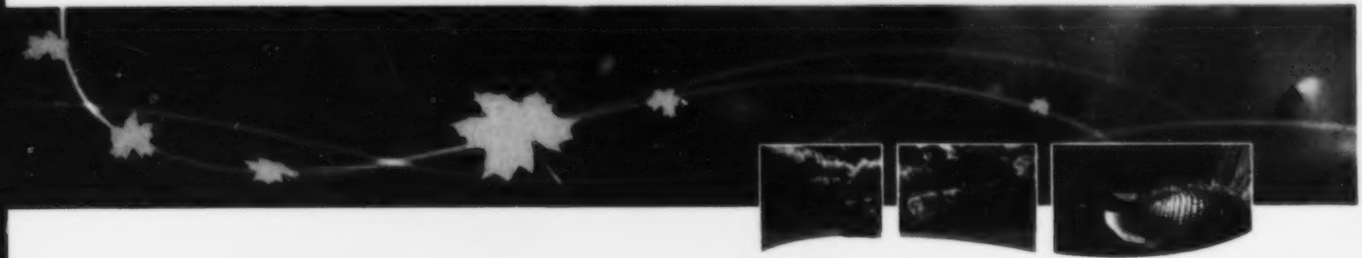

Atlas of Pelagic Seabirds off the West Coast of Canada and Adjacent Areas

James K. Kenyon, Ken H. Morgan, Michael D. Bentley,
Laura A. McFarlane Tranquilla, Kathleen E. Moore

Pacific and Yukon Region

Canadian Wildlife Service
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ATLAS OF PELAGIC SEABIRDS OFF THE WEST COAST OF CANADA AND ADJACENT AREAS

James K. Kenyon[1]
Ken H. Morgan[2]
Michael D. Bentley[3]
Laura A. McFarlane Tranquilla[4]
Kathleen E. Moore[5]

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[1]Ducks Unlimited Canada, P.O. Box 31775, Whitehorse, YT, Y1A 6L3
[2]Canadian Wildlife Service, Environment Canada, c/o Institute of Ocean Sciences, 9860 W. Saanich Rd., Sidney, BC, V8L 4B2
[3]366 Ivor Rd., Victoria, BC, V9E 2C1
[4]Cognitive and Behavioural Ecology, Memorial University of Newfoundland, St. John's, NL, A1B 3X9
[5]Canadian Wildlife Service, Environment Canada, Pacific Wildlife Research Centre, 5421 Robertson Rd., RR#1, Delta, BC, V4K 3N2

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Raft of Common Murres (*Uria aalge*).

ABSTRACT

The rationale for developing this atlas was the recognized need for a product that could assist with: coastal zone and conservation area planning; emergency response to environmental disasters; and identifying areas of potential interactions between seabirds and anthropogenic activities. In addition, the data used to develop the document provides a baseline to compare with future seabird distributions in order to measure the impacts of shifts in composition, abundance and/or distribution of prey, and climatic and oceanographic changes.

In 1991, Environment Canada published the *Atlas of pelagic birds of western Canada* (Morgan *et al.* 1991) to describe the spatio- temporal distribution of pelagic seabirds off Canada's west coast. Since then, considerably more data have been collected and an update of that original atlas is warranted.

Here we present maps displaying the distribution of 48 species of seabirds and two species pairs. Seabird surveys were conducted aboard commercial and Canadian federal government 'ships-of-opportunity' from 1982-1983 and 1991-2005 within the study area (45° N to 58° N and from the coast to 148° W). Sightings of rare species that came from other sources (including some pre-1982 and post-2005) are also included in order to present as complete a picture as possible.

For 33 species and one species pair, the average densities within 5' latitude by 5' longitude grid cells are displayed seasonally. The seabirds mapped in this manner include 11 species of *Procellariiformes* (albatrosses, fulmars, petrels, shearwaters and storm-petrels), and 24 species of *Charadriiformes* (phalaropes, skuas, gulls, terns and auks).

The sighting locations for an additional 15 species and one species pair are also mapped. This group, comprised of 10 species of *Procellariiformes* and seven species of *Charadriiformes* includes species that are relatively uncommon to rare in the study area (but previously documented); and species that are extremely rare and/or have not been documented and thus remain unconfirmed.

RÉSUMÉ

L'évidente nécessité de disposer d'un produit ayant la possibilité d'appuyer la planification des zones côtières, la conservation des aires, les interventions en cas d'urgence de désastres environnementaux et la désignation des aires d'interactions potentielles entre les oiseaux de mer et les activités humaines a motivé l'élaboration de cet atlas. De plus, les données utilisées dans le cadre de la rédaction de cet ouvrage fournissent une base de référence qui permettra de faire des comparaisons avec les répartitions futures des oiseaux de mer en vue de mesurer les répercussions des changements relativement à la composition, à l'abondance ou à la répartition des proies, ainsi que les répercussions des changements climatiques et océanographiques. En 1991, Environnement Canada a publié l'*Atlas of pelagic birds of western Canada* (Morgan *et al.* 1991) pour décrire la répartition spatiotemporelle des oiseaux de mer pélagiques au large de la côte ouest du Canada. Puisqu'un nombre considérable de nouvelles données ont été recueillies depuis, une mise à jour de l'atlas initial s'avérait donc justifiée.

L'atlas comprend des cartes sur la répartition de 48 espèces d'oiseaux de mer ainsi que de deux couples d'espèces. Des recensements d'oiseaux de mer ont été menés à bord de navires commerciaux et de « navires occasionnels » du gouvernement fédéral du Canada, de 1982 à 1983 et de 1991 à 2005, à l'intérieur de la zone d'étude (du 45° N au 58° N et de la côte au 148° O). Des observations d'espèces rares issues d'autres sources (y compris certaines antérieures à 1982 et d'autres ultérieures à 2005) ont également été ajoutées en vue de présenter une image aussi complète que possible de la situation. Les densités moyennes d'une grille avec cellules de 5' de latitude sur 5' de longitude sont affichées par saison pour 33 espèces et un couple d'espèces. Les oiseaux de mer ainsi cartographiés comprennent 11 espèces de *Procellariiformes* (des albatros, des fulmars, des pétrels, des puffins et des océanites), ainsi que 24 espèces de *Charadriiformes* (des phalaropes, des labbes, des mouettes et goélands, des sternes et des pingouins).

Les emplacements des observations pour 15 espèces additionnelles et un couple d'espèces sont aussi cartographiés. Ce groupe, composé de 10 espèces de *Procellariiformes* et de 7 espèces de *Charadriiformes*, comprend des espèces relativement peu connues ou rares, ou des espèces qui n'ont pas été documentées. Par conséquent, ces dernières demeurent non confirmées.

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1. INTRODUCTION

There have been numerous studies describing seabird distribution off Canada's west coast (e.g., Vermeer *et al.* 1989, Hay 1992, Wahl *et al.* 1993, Logerwell and Hargreaves 1996, Boyd *et al.* 2000, Ryder *et al.* 2001, Burger 2003, Burger *et al.* 2004, McFarlane Tranquilla *et al.* 2005a, Yen *et al.* 2005, O'Hara *et al.* 2006, Batten *et al.* 2006), but there have been few attempts to develop a synoptic view of the entire region (e.g., Morgan *et al.* 1991). Given that human impacts on our oceans increasingly pose threats to seabirds, it is critical to have a better understanding of where and when seabirds are located in marine waters. Much time has passed since Morgan *et al.* (1991) described the spatio-temporal distribution of pelagic seabirds off Canada's west coast. Much new data has accumulated since 1991 and this warrants an update of that original atlas.

As described in Morgan *et al.* (1991), pelagic surveys began in 1981. At that time, the survey objectives were to increase the understanding of the at-sea distribution of seabirds and to present baseline data that could be used to assess the environmental impacts.

The atlas presented here will help others to identify areas of overlap between seabirds and locations where commercial fisheries, oil and gas exploration and development, chronic oiling, and catastrophic oil spills represent potential conservation threats. It will also serve as a useful tool in planning of marine protected areas and coastal zone management.

This atlas contains maps that illustrate the seasonal distribution of 48 species of seabirds (and four other taxa that were difficult to identify to the species level) in the marine environment off the coast of British Columbia (BC). In addition, we calculated and mapped *grid cell importance scores*, (comprised of a combination of *average total bird density*, *species richness score*, and *species at risk score*) in order to identify locations that might represent areas of importance to seabirds.

There are some limitations regarding the data used in this atlas. Ship-based surveys were conducted opportunistically, and therefore survey effort was not evenly distributed. Depending on species or locations, this could lead to potential spatio-temporal biases in the interpretation of the bird distribution patterns. With one exception (the Line P surveys, see below), it is unlikely that the data would be used in estimating population sizes or for detecting trends in abundance over time. The scale of maps provided will probably not be conducive to local (fine-scale)

planning in most instances, but the maps will most likely be of great assistance in regional-scale coastal and marine planning.

2. STUDY AREA AND METHODS

2.1 Study Area

The study area is defined as the area of the North Pacific (N Pacific) bounded by the North American (N American) coast to the east, 148° W longitude to the west and 58° N latitude to the north and 45° N latitude to the south, and. The study area encompasses all of Canada's west coast Exclusive Economic Zone (EEZ) which extends 200 nautical miles (370.4 km) off the coast of BC. It also includes waters within the EEZ of the United States and some international waters. The extent of the study area was deliberately chosen in order to include the extensive data set for what is known as Line P; this is a repeated survey that runs from Victoria, BC to Ocean Station Papa (hereafter referred to as OSP) located at 50° N, 145° W. Transects that extended beyond the boundaries of the study area were truncated, with the transect segment inside the study area assigned a proportional number of birds.

The complexities of the oceanographic features within the study area outlined in this atlas are not described here. A detailed account of the oceanography of the N Pacific Ocean can be found in Dodimead *et al.* (1963), Favorite *et al.* (1976), and Thomson (1981).

This atlas uses a number of geographic features to describe the distribution of seabirds in the study area including marine and bathymetric features (Fig. 1) and terrestrial reference points (Fig. 2). Throughout the atlas, areas shallower than 200 m are referred to as the continental shelf; the 200 m isobath is called the shelfbreak; and, the zone between the 200 m and 500 m isobaths is considered to be the upper slope. The remaining area west of the upper slope is generally referred to as the offshore or the pelagic zone.

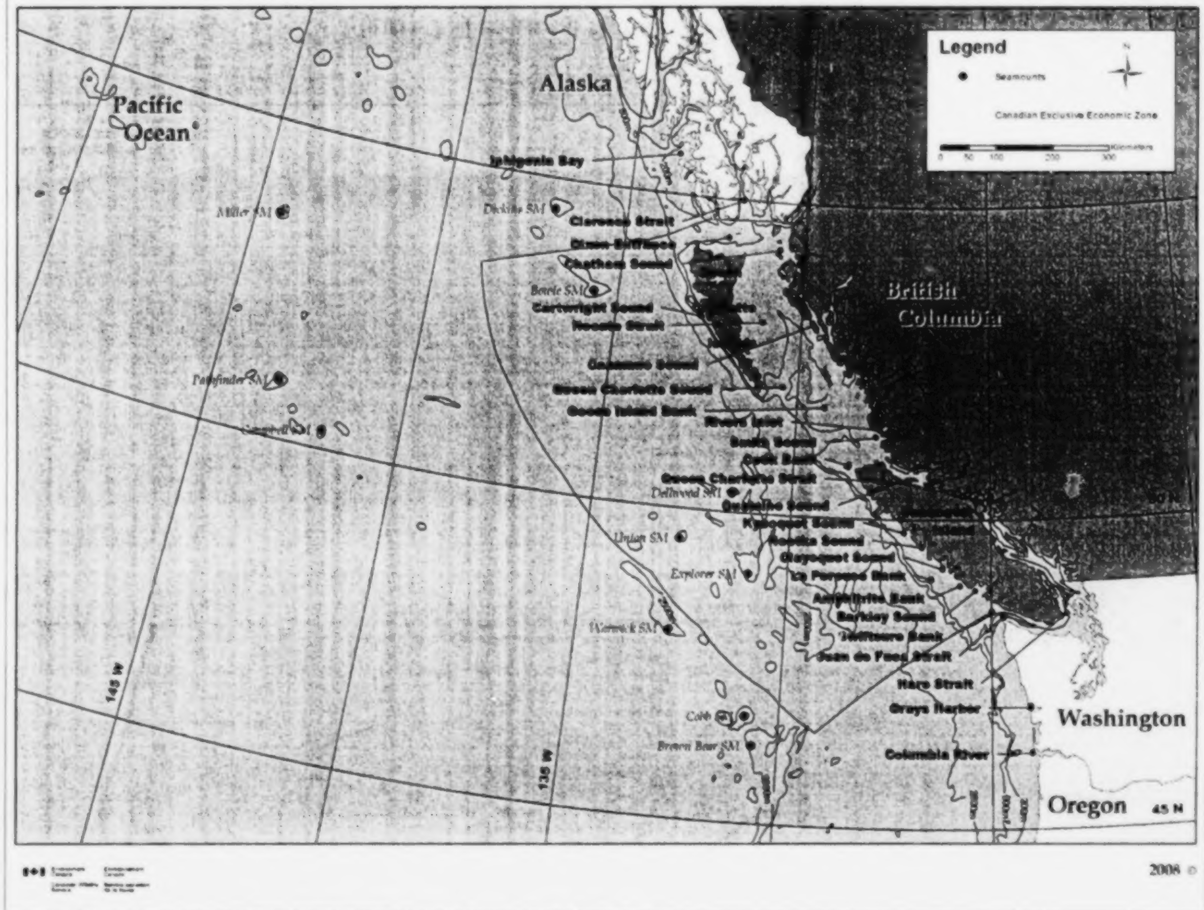

Figure 1. Marine and bathymetric features of the study area.

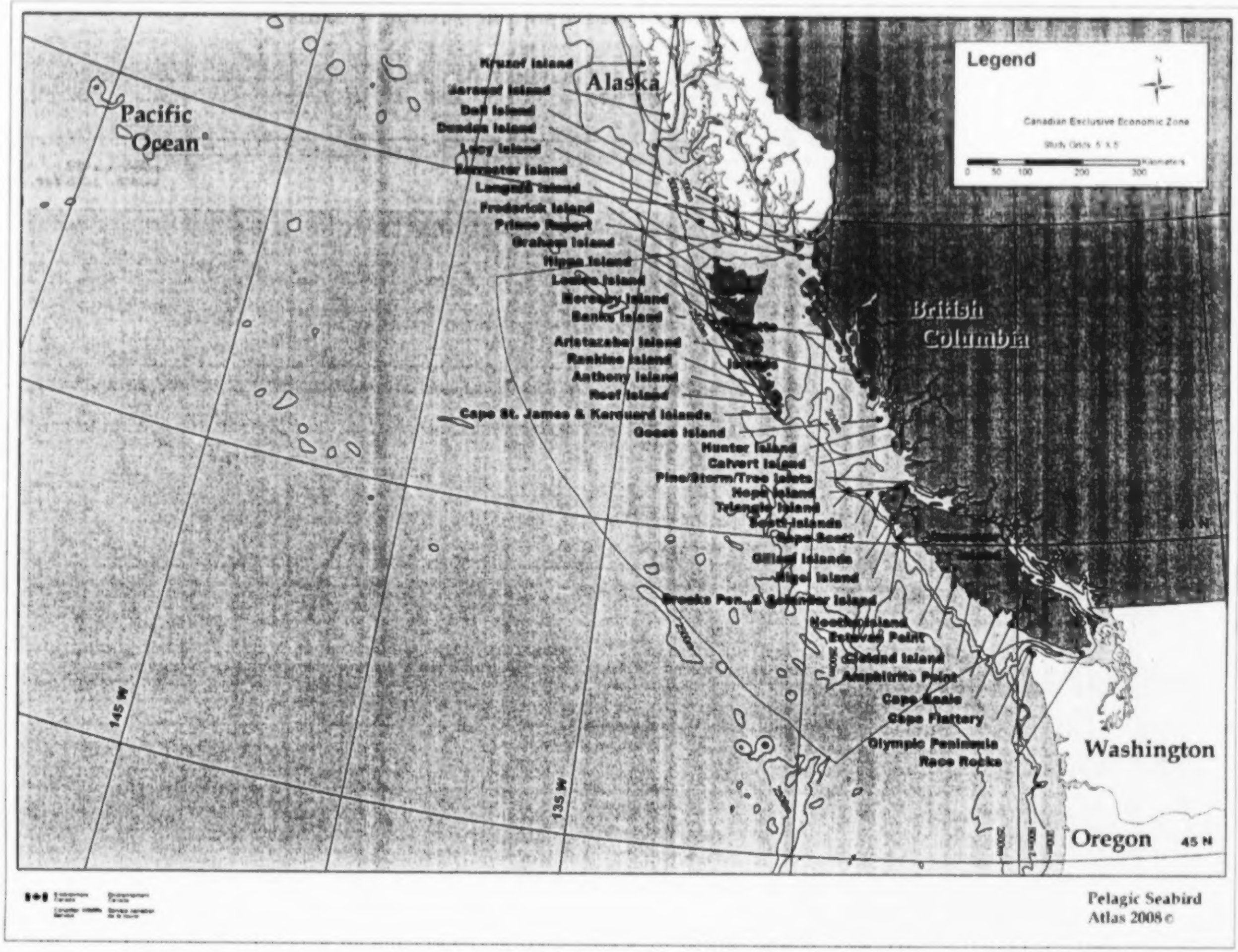

Figure 2. Terrestrial features of the study area.

2.2 Methods

2.2.1 Pelagic Bird Surveys

Pelagic bird data were collected aboard ships-of-opportunity; most of which were involved in oceanographic studies. Data were collected by a total of nine observers, during more than 60 cruises conducted between 1982-1983 and 1991-2005. The survey methodology employed has been described in detail elsewhere (Brown 1986, Morgan *et al.* 1991). Briefly, observations were recorded on data sheets whenever the ship was in motion at a speed of at least 5 knots (9.25 km/h) on a constant course. Observations were terminated when the ship halted or was within 3 km of land. Observations were conducted during daylight hours only and were halted during rough seas, fog, or heavy rain. Depending on the vessel, the observer was generally positioned above the ship's bridge, from approximately 12 to 20 m above the water. Using either hand-held units or the ship's GPS, positions (and time) were noted when the surveys commenced, at regular intervals (generally not longer than 30 minutes), when the ship altered course, and when surveys were terminated.

For the majority of transects, the width of the survey strip (transects) extended out to 250 m from the side of the vessel, on one side only. In some early surveys, both sides of the vessel were surveyed. In all years, if weather conditions (e.g., fog) dictated, the strip width was less than 250 m.

All birds observed within the strip were counted and recorded to species when possible. Birds that could not be identified to species were identified to genus or family (i.e. murre sp., or alcid sp.). Observers recorded the data in a running series of transects; each transect generally lasting 5 minutes. Birds seen on the water were tallied separately from those in flight. Ship followers such as large gulls or albatrosses were counted only once. No attempt was made to adjust (e.g., by using the snapshot method, Tasker *et al.* 1984, Spear *et al.* 1992) for the movement of birds flying into or out of the count zone.

The area surveyed was determined by multiplying the transect width by the transect length. Bird counts (the sum of birds in flight and on the water by species) were converted to densities (birds per square kilometre) by dividing the counts by the area surveyed, for each transect.

At-sea surveys have continued since the end of 2005 (the cut-off date for the development of the seasonal distribution maps). However, for rare species, sightings from pelagic surveys through to

September 2007 were included as were recent data from other sources. We decided to include the more recent sightings of rare species in order to compile as much information as possible in a single location; thereby further expanding our understanding of the composition, abundance, distribution and variability of the seabird community. Although to a lesser extent than first experienced and described in Morgan *et al.* (1991), a small number of the observers had less at-sea survey experience than the core observers, and as a consequence, there is an elevated risk of species misidentification. Following Morgan *et al.* (1991), questionable observations were included only if the following criteria were met:

the observation was accompanied by a very convincing field description, or

the observation was of an easily identified (but rare) species provided that the species has previously been observed within the study area by a skilled observer, or,

the observation was of a common species that is easily identified but was observed out of the 'typical' season.

2.2.2 Data Analysis

The study area was partitioned into grid cells of 5 minutes latitude by 5 minutes longitude; each cell was approximately 55 km^2 in size (although the exact surface area varies with latitude). Choosing 5' x 5' grid cells allowed us to summarize the distribution of the seabirds, while still providing a relatively high spatial resolution. Transects were assigned to their respective grid cells. Transects that extended across grid cells were split up and all associated data assigned proportionally to each grid cell. The bird values in all of the transects that fell within each grid cell were averaged (arithmetic mean) to generate seasonal species *average grid cell density*; and, *average total bird density* for each grid cell. *Average total bird density* was calculated as the mean density of all bird species combined within each grid cell. For transects where counts of birds were identified only to groupings (e.g., dark shearwater species, large gull species, etc.), we made no attempt to pro-rate the numbers to species. With the exception of counts of Red (*Phalaropus fulicarius*) and Red-necked (*P. lobatus*) Phalaropes in non-breeding plumage; and Hawaiian (*Pterodroma sandwichensis*) and Galapagos (*P. phaeophygia*) 'Dark-rumped' Petrels (see below), counts identified to grouping only were not used in the calculation of *average grid cell density*.

To determine the *relative abundance* throughout the year, the monthly sum of individuals of each species across all years was calculated for four sub-regions within the study area. These

four sub-regions were divided at 52° N latitude and at the 500 m isobath. Areas that were shallower than 500 m but were not along the continental slope (e.g., seamounts) were considered to be part of the offshore sub-regions. The sub-regions were chosen to best represent the differences in the distribution of species on a north-south basis, as well as to distinguish between the continental shelf/upper slope and the offshore areas. To control for differences in survey effort, the monthly sums were divided by the total area surveyed to give an estimate of average density. Average density was classified into one of five categories based on the following logarithmic scale for species that had a non-zero density estimate:

1. Rare: <0.01 birds/km^2;
2. Few: 0.01-0.10 birds/km^2;
3. Common: 0.11-1.00 birds/km^2;
4. Abundant: 1.01-10.00 birds/km^2;
5. Numerous: >10.00 birds/km^2.

For some species there was only a single observation within a sub-region. In these cases, average density classifications were not assigned; the species was simply noted as having been observed. For species with more than one individual observed, but only within a single month, we calculated the average density and assigned a density category.

Species richness scores were calculated as the total number of species observed in each grid cell. Observations described to family or genus only were omitted, except in cases where no individual species (from within that family or genus) had been observed in the grid cell. Within each grid cell the *species at risk score*, a proxy for the number of listed species and their status, was calculated by summing the assigned values for each species that had occurred in the cell. Values were assigned based upon the listing status of each species, by either the Species at Risk Act or the International Union for Conservation of Nature and Natural Resources (IUCN, IUCN 2008). Species that were not listed were assigned a value of zero. Species listed as *Near Threatened* or *Special Concern* were assigned a value of 1; those listed as *Vulnerable, Threatened, Endangered*, or *Critically Endangered* species were given a value of 2. Table 1 lists all of the species at risk we encountered.

Table 1. Threat status categories of seabird species observed during the study, using either their global ranking or their Canadian ranking. Species not listed were considered to be of Least Concern (as per the IUCN) and were assigned a score of zero (0).

Species		IUCN Listing [1]	SARA Listing [2]	Score
Black-footed Albatross	*Phoebastria nigripes*	E	SC	2
Cook's Petrel	*Pterodroma cooki*	E		2
Marbled Murrelet	*Brachyramphus marmoratus*	E	T	2
'Dark-rumped' Petrel (Galapagos# or Hawaiian*)	*Pterodroma phaeophygia# or P. sandwichensis**	#CE/ *V		2
Laysan Albatross	*Phoebastria immutabilis*	V		2
Short-tailed Albatross	*Phoebastria albatrus*	V	T	2
Solander's Petrel	*Pterodroma solandri*	V		2
Buller's Shearwater	*Puffinus bulleri*	V		2
Pink-footed Shearwater	*Puffinus creatopus*	V	T	2
Xantus's Murrelet	*Synthliboramphus hypoleucus*	V		2
Mottled Petrel	*Pterodroma inexpectata*	NT		1
Murphy's Petrel	*Pterodroma ultima*	NT		1
Sooty Shearwater	*Puffinus griseus*	NT		1
Black-vented Shearwater	*Puffinus opisthomelas*	NT		1
Ancient Murrelet	*Synthliboramphus antiquus*	LC	SC	1

[1]CE = Critically Endangered, E = Endangered, V = Vulnerable, NT = Near Threatened, LC = Least Concern
[2]Species At Risk listing: T = Threatened, SC = Special Concern

Following each of the above-noted analyses, each grid cell was given a score out of 1 based upon its relative rank compared to the maximum scoring grid cell. For example, the grid cell that had the highest *average total bird density* was assigned a density score of 1 and all other grid cells were given a proportional score (i.e., the calculated value was divided by the maximum value). To generate the *grid cell importance score* for each grid cell, we first ran three separate analyses (*average total bird density*, *species richness*, and *species at risk*). For each grid cell, the sum of the three standardized values was determined to create the *grid cell importance score*.

Due to the uneven survey effort, we tested for relationships between effort and *species richness score*, as well as with *species at risk score* and found that correlations existed between both indices and effort (i.e., greater effort generally resulted in higher *species richness* and *species at risk scores*). To correct for spatio-temporal heterogeneity in effort, we calculated residuals from spline curves modeling effort and the two indices, and used these semiparametric residuals in ensuing analyses (i.e., residuals are standardized correcting for variation in effort). To calculate

residuals we used PROC TSPLINE (SAS Version 8: SAS Institute, Carey NC) with a DF = 10, as we found that model fitting with higher DF resulted in relationships that were too smoothed (i.e., linear rather than curvilinear).

In order to add all three scores together, it was necessary to place them on the same scale; to do that we used a standardized distribution (where the mean = 0, and the standard deviation = 1). To place the *average total bird density* scores on this scale, the scores were arcsine transformed and then standardized. For both the *species richness* and the *species at risk* analyses, the residuals were standardized.

To display the *grid cell importance score*, grid cells were classified into one of five categories, where each class accounted for 20% of all grid cells (i.e., grid cells in black represent the top 20% of the cells with respect to the *grid cell importance score*; red grid cells represent the next 20% of the cells; etc.).

The *average grid cell density* of.each grid cell was classified on a logarithmic scale and displayed using a colour code. For each season, only grid cells that had at least a portion of a transect within it were displayed on the maps. Grid cells that are not outlined on each map were not surveyed; we do not know whether or not birds were present in those grid cells.

Each transect was assigned to a season where the seasons were defined as:

1. Winter: 16 December through 15 March;
2. Spring: 16 March through 15 June;
3. Summer: 16 June through 15 September;
4. Fall: 16 September through 15 December.

These seasonal breaks were chosen simply to coincide with the dates that had been used in the previous atlas (Morgan *et al.* 1991).

For each season and for every species with sufficient data, the *average grid cell density* was calculated. Because of the difficulty of identifying to the species level Red and Red-necked Phalaropes in non-breeding plumage; and Hawaiian and Galapagos ('Dark-rumped') Petrels, we analyzed those data as species pairs. All years were pooled, resulting in less bias due to one-time only aggregations caused by factors such as adverse weather (Guzman and Myres 1983).

For a number of species considered very uncommon to rare (or unconfirmed) within the study area, we do not present figures showing the seasonal *average grid cell density*; instead, we show the locations of all observations, colour-coded to identify the season the sightings took place.

For these species, we also present (Appendix 1) the dates, locations and the number of birds observed.

All point locations noted in this atlas are presented in decimal degrees, rounded to the nearest 1/100th of a degree. That degree of accuracy corresponds to an accuracy of approximately ±1 km for both latitude and longitude.

3. RESULTS

In total, 5,216 grid cells contained whole or partial transects. The largest total area surveyed occurred during spring, followed in descending order by summer, winter, and fall (Fig. 3). Most surveys occurred over the continental shelf/upper slope sub-regions, particularly during spring and summer (Fig. 4).

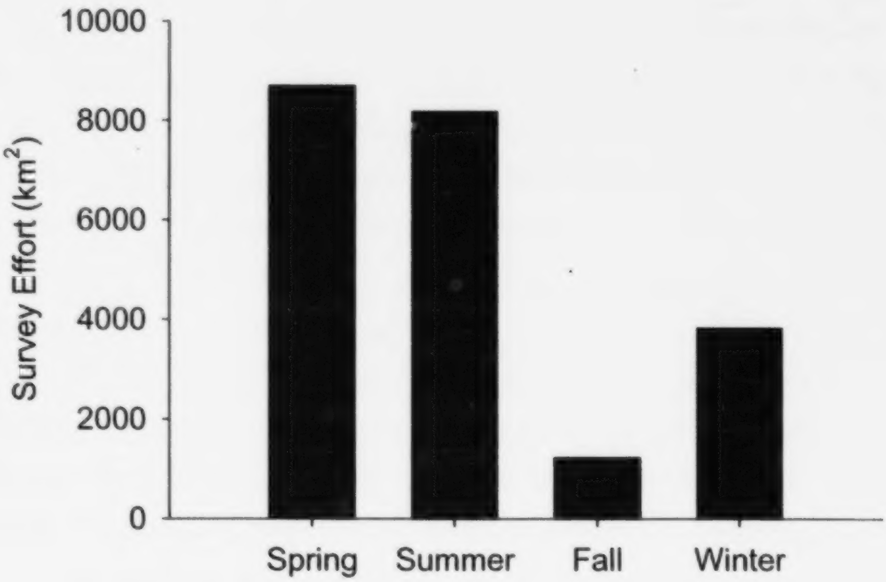

Figure 3. Total survey effort by season (all data combined).

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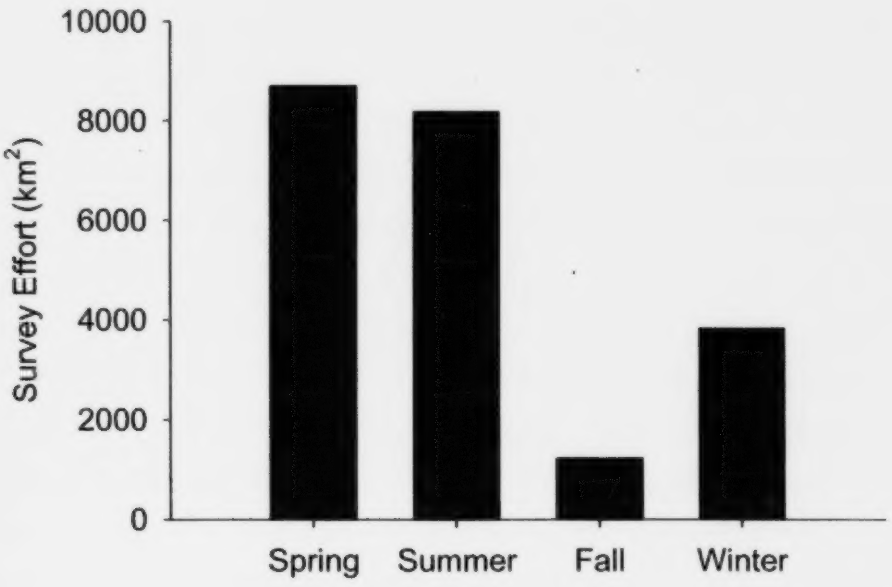


Figure 3. Total survey effort by season (all data combined).

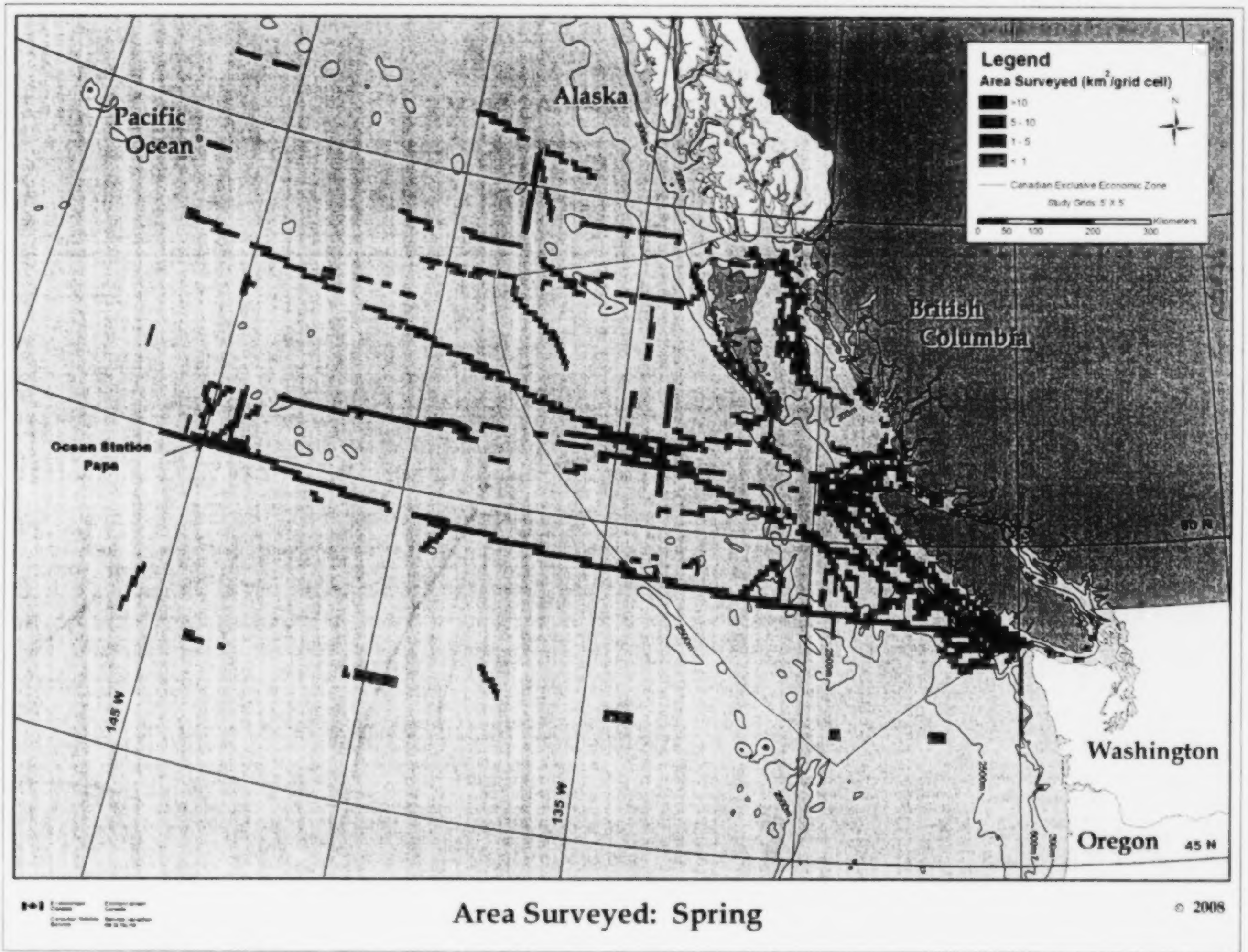


Figure 4A. Spatial representation of survey effort by season (all data combined).

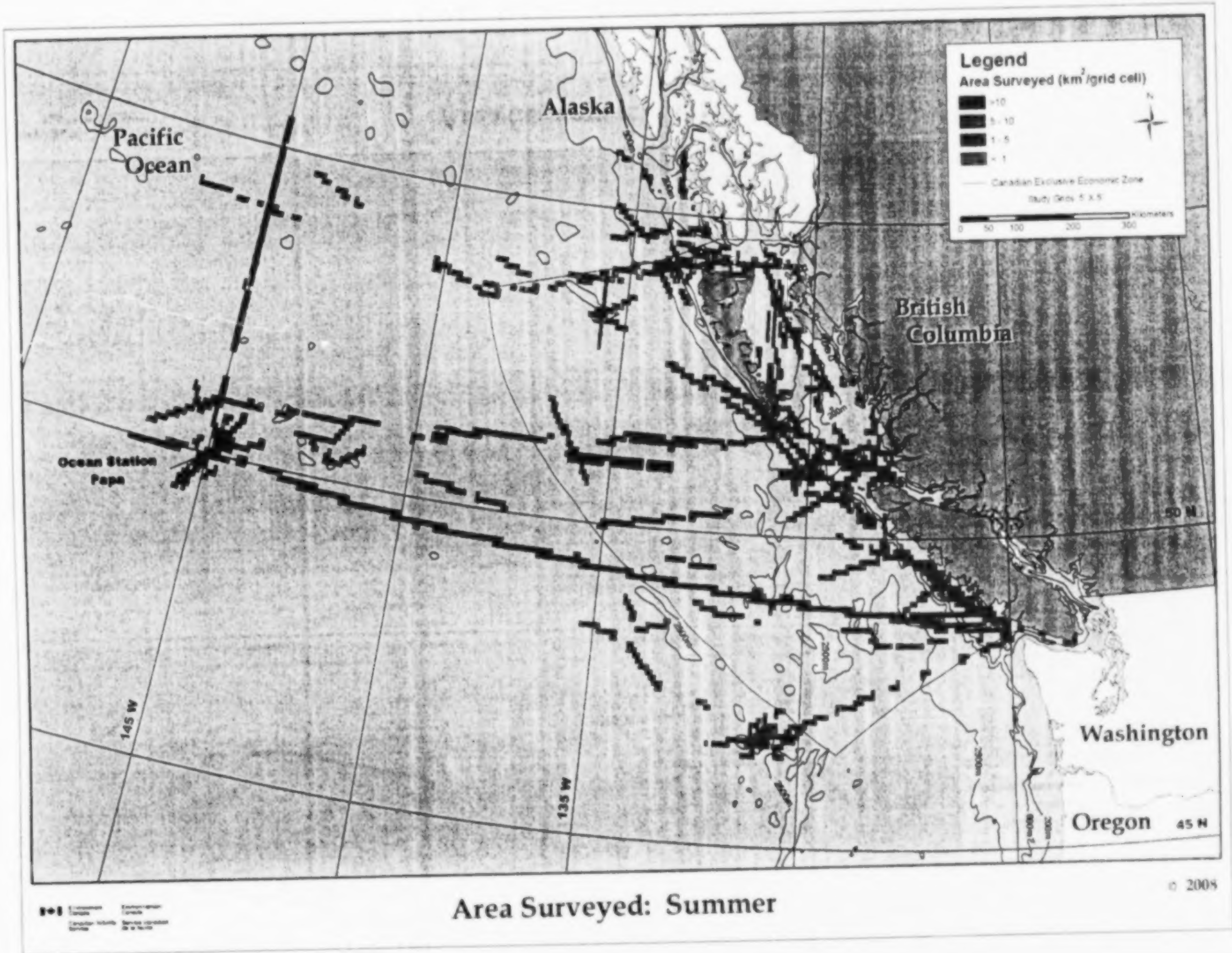


Figure 4B. Spatial representation of survey effort by season (all data combined).

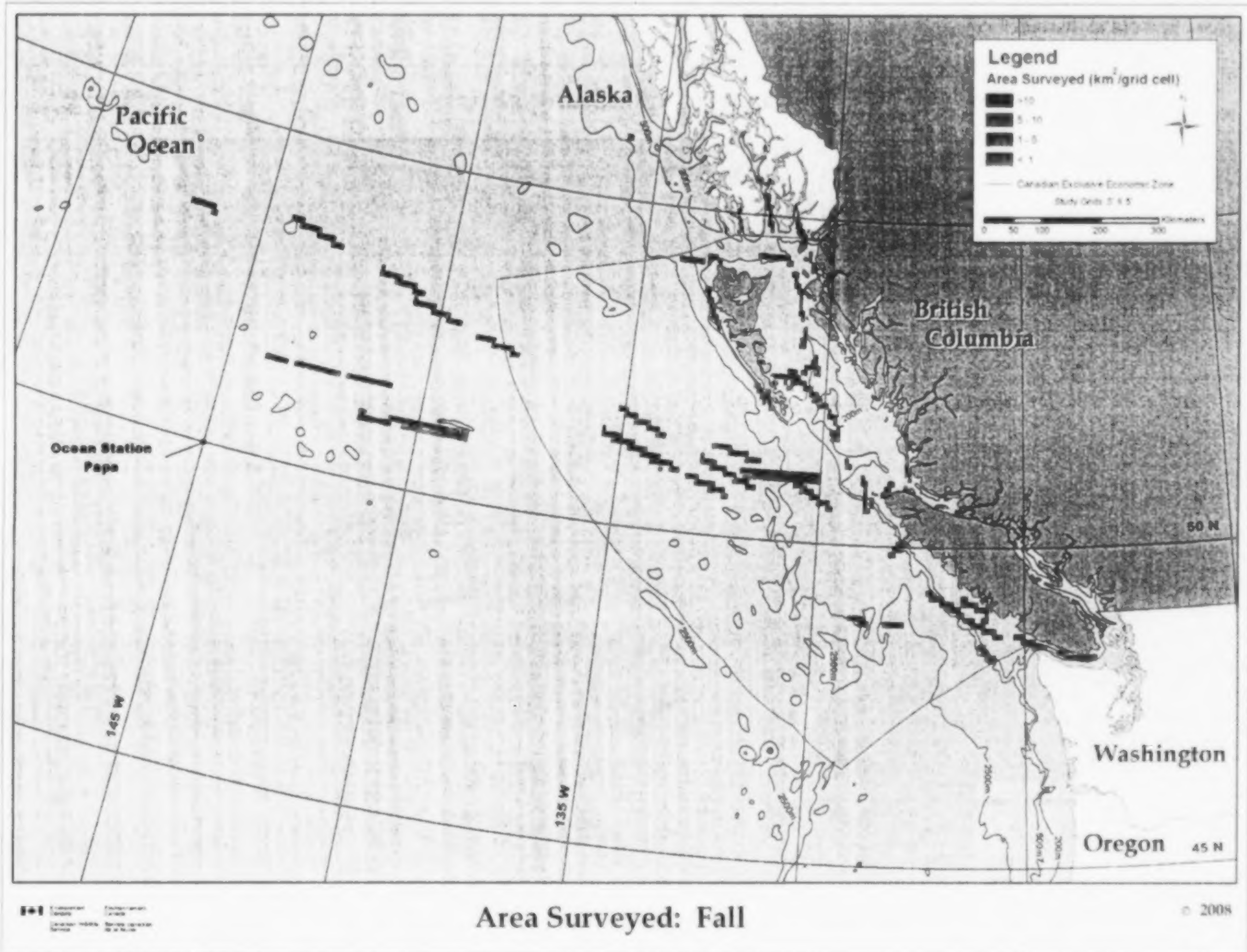


Figure 4C. Spatial representation of survey effort by season (all data combined).

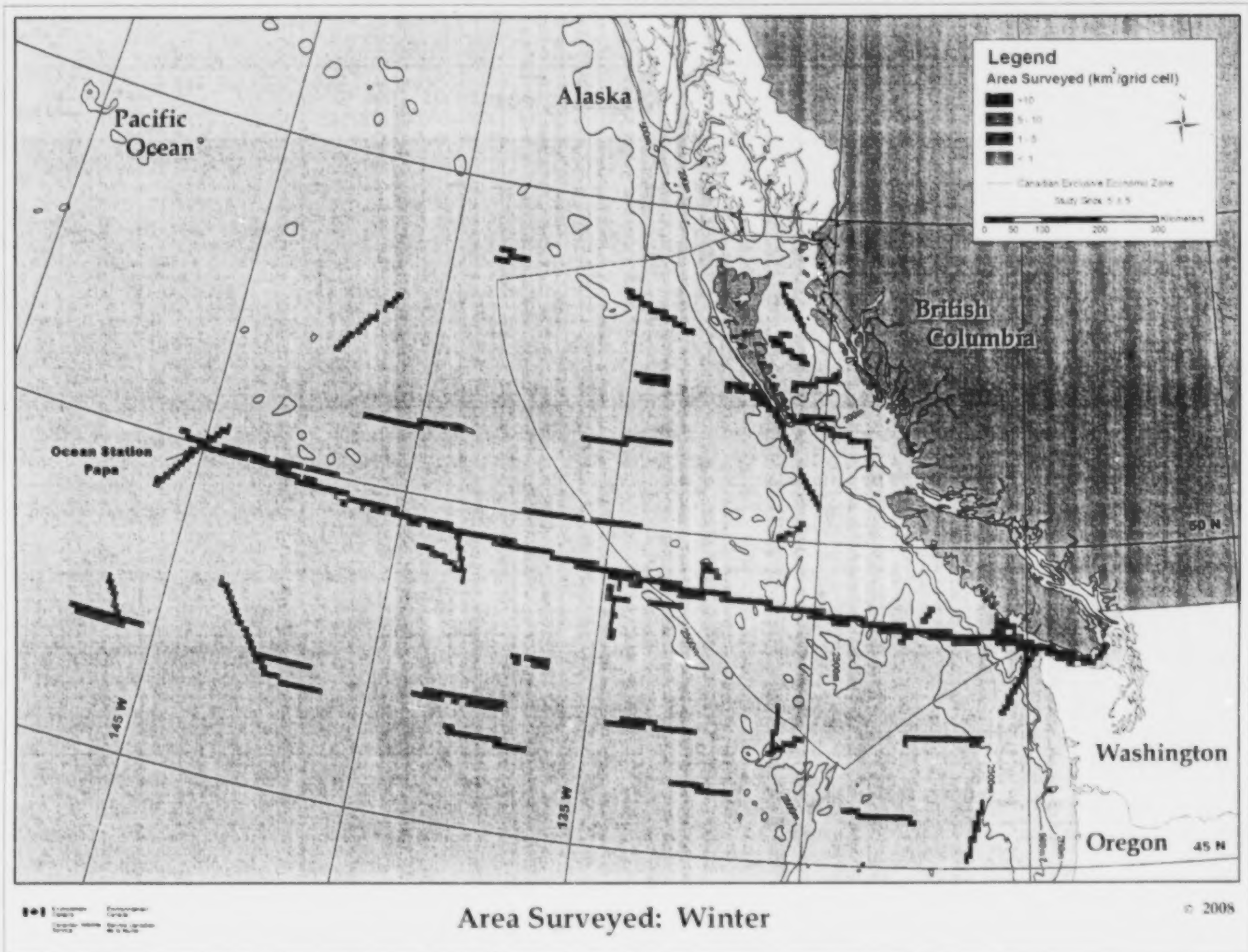


Figure 4D. Spatial representation of survey effort by season (all data combined).

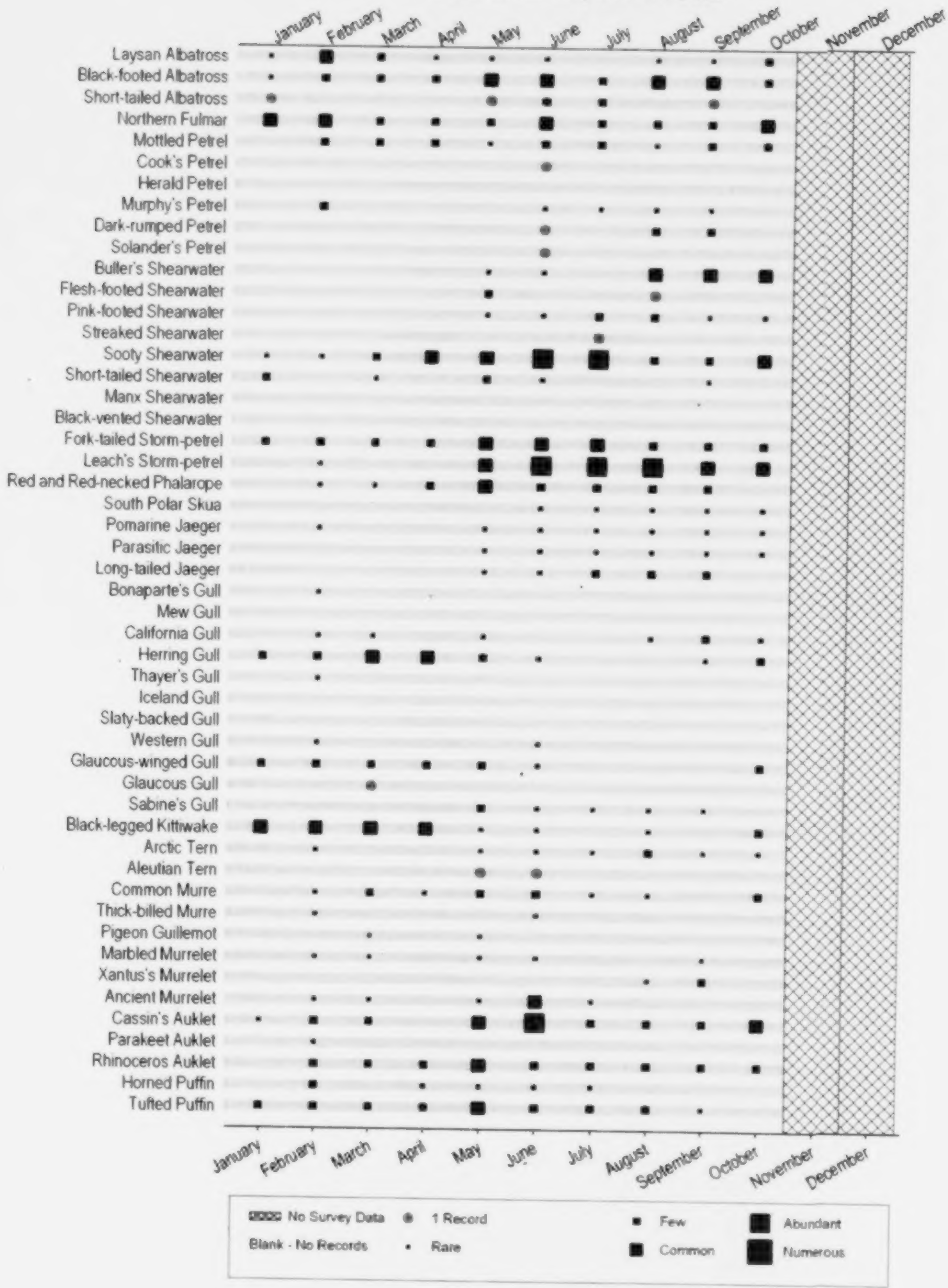
We conducted a total of 62 cruises, with most cruises occurring during June, February, and September. There were no surveys during the month of December and only a single survey was conducted in November (Fig. 5). Within a season, survey effort was not uniform; for example, most surveys conducted during what we have defined as winter, took place in February (Fig. 5). The *relative abundance* of each species within each sub-region is illustrated in Fig. 6. For many species, the *relative abundance* values were highest over the continental shelf/upper slope sub-regions compared to the offshore sub-regions. Additionally, the majority of species had higher *relative abundance* values in the southern sub-regions than in the northern sub-regions. Sooty Shearwaters (*Puffinus griseus*) were generally the most numerous species between March and September over the shelf/upper slope sub-regions. Other abundant species in summer months in the southern shelf/upper slope sub-region included Northern Fulmars (*Fulmarus glacialis*), Common Murres (*Uria aalge*), Rhinoceros Auklets (*Cerorhinca monocerata*), and California Gulls (*Larus californicus*). In late winter-early spring, Black-legged Kittiwakes (*Rissa tridactyla*) and Common Murres were most common in this sub-region. In the northern shelf/upper slope sub-region, all species had lower abundances compared to the south, particularly gulls. Abundances of most species were lower in the two offshore sub-regions than in the shelf/upper slope sub-regions. The most common species in both offshore sub-regions were Fork-tailed Storm-Petrels (*Oceanodroma furcata*) and Leach's Storm-Petrels (*O. leucorhoa*), while Northern Fulmars were common only in the northern offshore sub-region. Most murres and murrelets were found over the shelf/upper slope sub-regions.

Generally, there was a background density of between 1.0-10.0 birds/km^2 across the entire study area (Fig. 7). Higher *average total bird density* usually occurred in association with specific bathymetric features (e.g., above seamounts, banks, submerged canyons or the shelfbreak), or proximity to major seabird breeding colonies.

Figure 5. Timing of survey cruises conducted within the study area. In years with overlapping surveys, the bars have been offset to show individual surveys.


NORTH OF 52, OFFSHORE
January
February
March
April
May
June
July
August
September
October
November
December
Laysan Albatross
Black-footed Albatross
Short-tailed Albatross
Northern Fulmar
Mottled Petrel
Cook's Petrel
Herald Petrel
Murphy's Petrel
Dark-rumped Petrel
Solander's Petrel
Buller's Shearwater
Flesh-footed Shearwater
Pink-footed Shearwater
Streaked Shearwater
Sooty Shearwater
Short-tailed Shearwater
Manx Shearwater
Black-vented Shearwater
Fork-tailed Storm-petrel
Leach's Storm-petrel
Red and Red-necked Phalarope
South Polar Skua
Pomarine Jaeger
Parasitic Jaeger
Long-tailed Jaeger
Bonaparte's Gull
Mew Gull
California Gull
Herring Gull
Thayer's Gull
Iceland Gull
Slaty-backed Gull
Western Gull
Glaucous-winged Gull
Glaucous Gull
Sabine's Gull
Black-legged Kittiwake
Arctic Tern
Aleutian Tern
Common Murre
Thick-billed Murre
Pigeon Guillemot
Marbled Murrelet
Xantus's Murrelet
Ancient Murrelet
Cassin's Auklet
Parakeet Auklet
Rhinoceros Auklet
Horned Puffin
Tufted Puffin
No Survey Data
1 Record
Few
Abundant
Blank - No Records
Rare
Common
Numerous

SOUTH OF 52, OFFSHORE



NORTH OF 52, SHELF AND UPPER SLOPE

Figure 6. Species *relative abundance* by month in the four study area sub-regions.

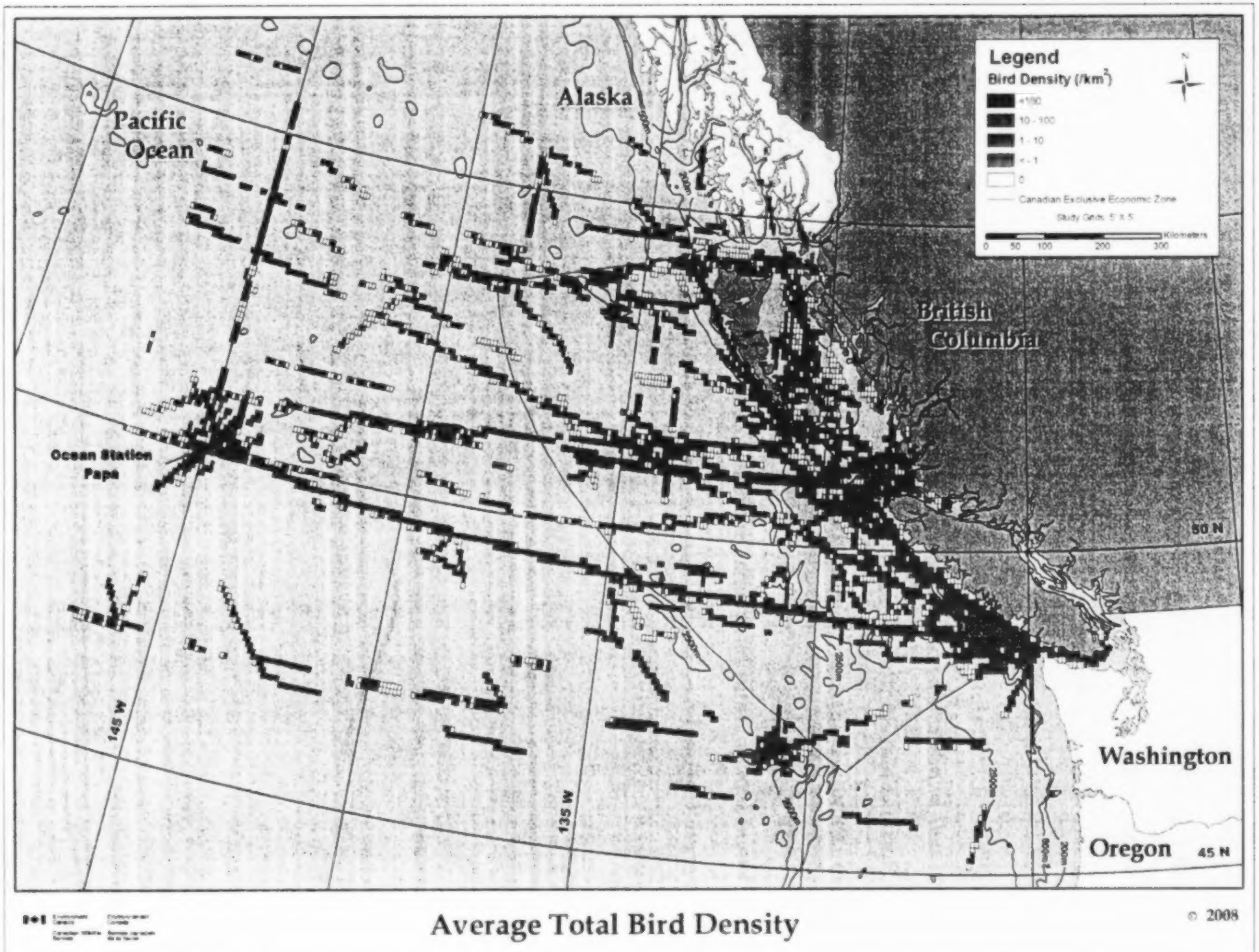


Figure 7. *Average total bird density* by grid cell (all data combined).

The highest *species richness scores* (uncorrected for survey effort) occurred along the Line P transect to OSP, likely reflecting the high survey effort along this repeated route (Fig. 8). Most grid cells had between one and five observed species of seabirds; high *species richness scores* were relatively rare. Generally, the areas with higher *species richness scores* closely corresponded with areas of high *average total bird density*.

Similar to the pattern of *species richness scores*, grid cells along the route to OSP had high *species at risk scores* (Fig. 9, uncorrected for survey effort); as did areas along the outer edge of the shelf and over areas characterized by abrupt bathymetric change (e.g., La Perouse and Cook Banks).

The highest *grid cell importance scores* occurred along the shelfbreak, especially over the Amphitrite, La Perouse and Swiftsure Banks complex; most of Queen Charlotte Sound including Cook and Goose Island Banks; along the west and north coasts of the Queen Charlotte Islands (QCI); and over Bowie and Union Seamounts (Fig. 10). Note that some of the areas showing low *grid cell importance scores* could have been the result of few surveys occurring there, especially during e.g., the winter when there are few species and low numbers of birds present, rather than during all four seasons over multiple years.

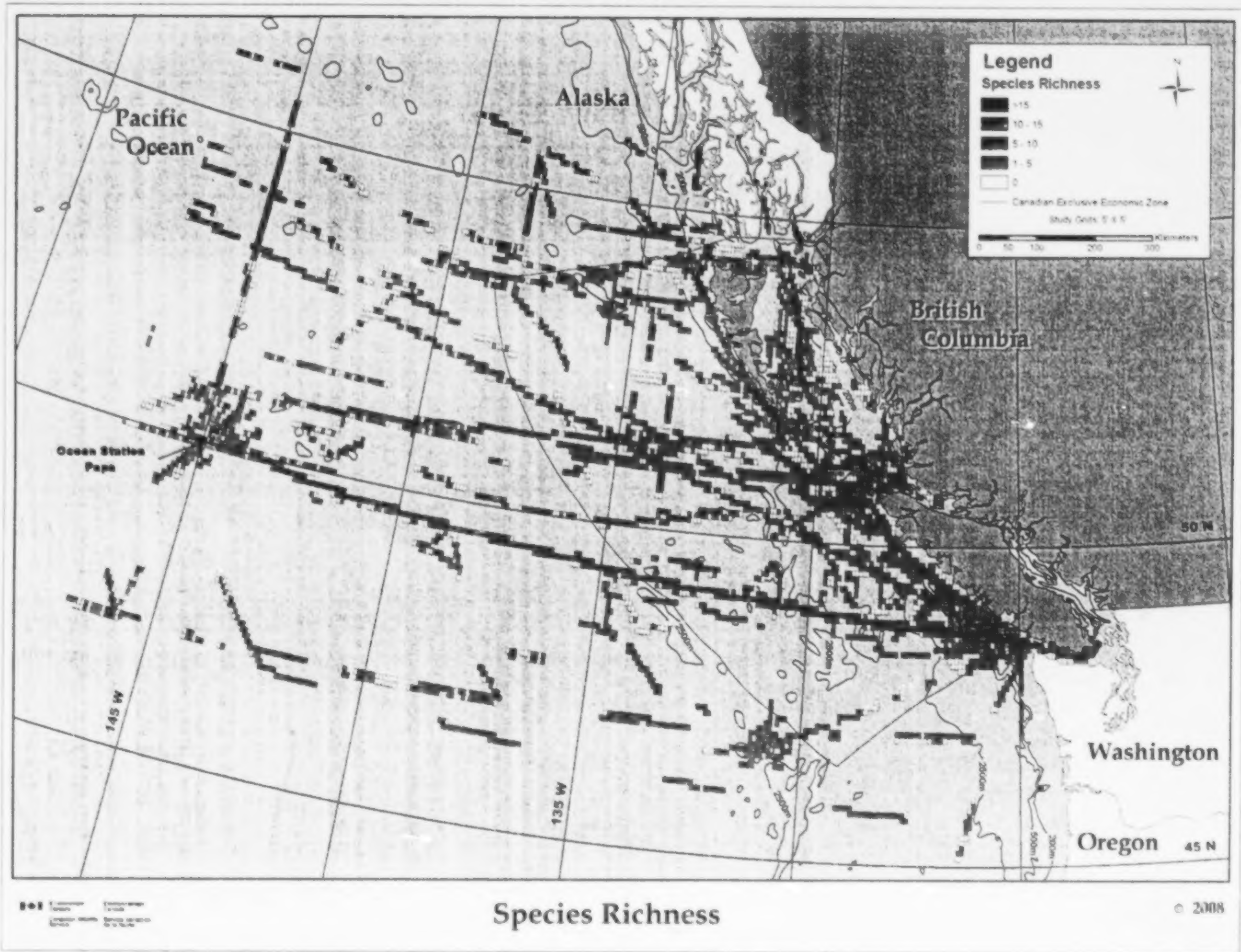


Figure 8. *Species richness scores* by grid cells (all data combined).

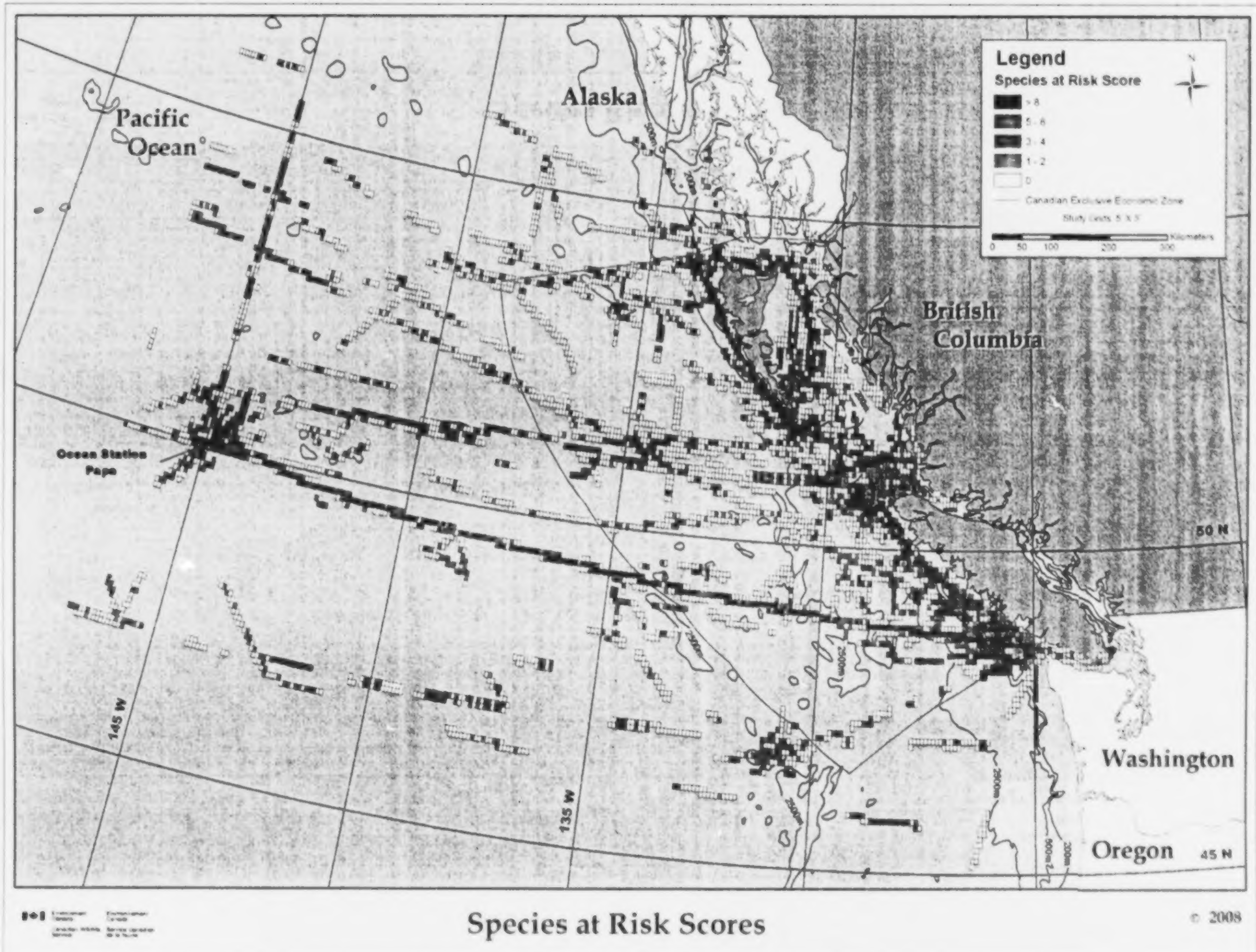


Figure 9. *Species at risk scores* by grid cells (all data combined).

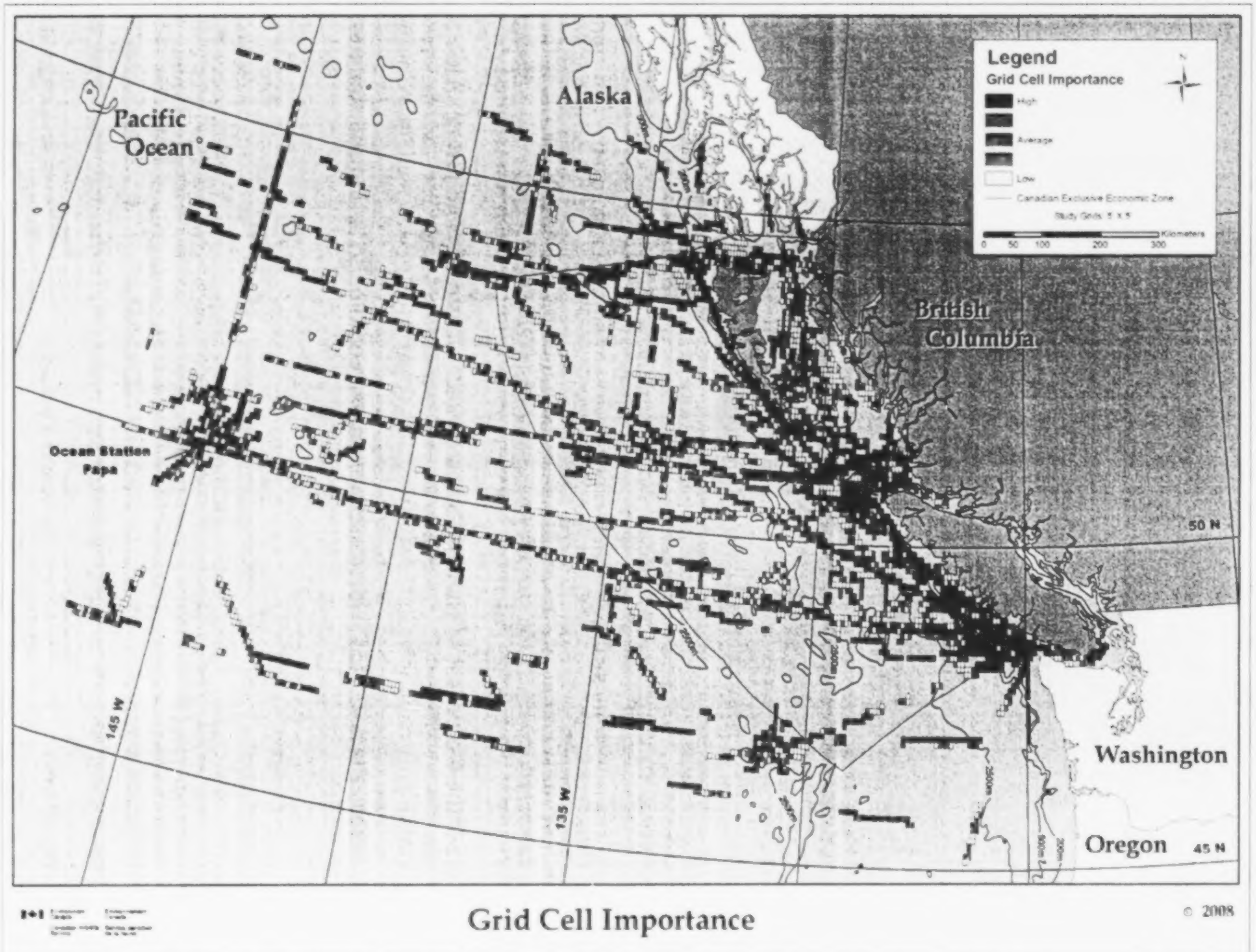


Figure 10. *Grid cell importance scores* (all data combined).

3.1 Species Accounts

3.1.1 Albatrosses

Black-footed Albatross (*Phoebastria nigripes*).
© John Ford.

Albatrosses are surface-feeding seabirds. Their diet consists of squid, crustaceans, fish, and flying fish eggs. The most abundant species of albatross in the northeastern N Pacific is the Black-footed Albatross, the Laysan Albatross is a common visitor, and the Short-tailed Albatross is relatively rare off the west coast of Canada. Black-footed Albatrosses and Laysan Albatrosses have differing temporal distributions in the study area; Laysan Albatrosses were more numerous during winter whereas Black-footed Albatrosses were most common in spring and summer.

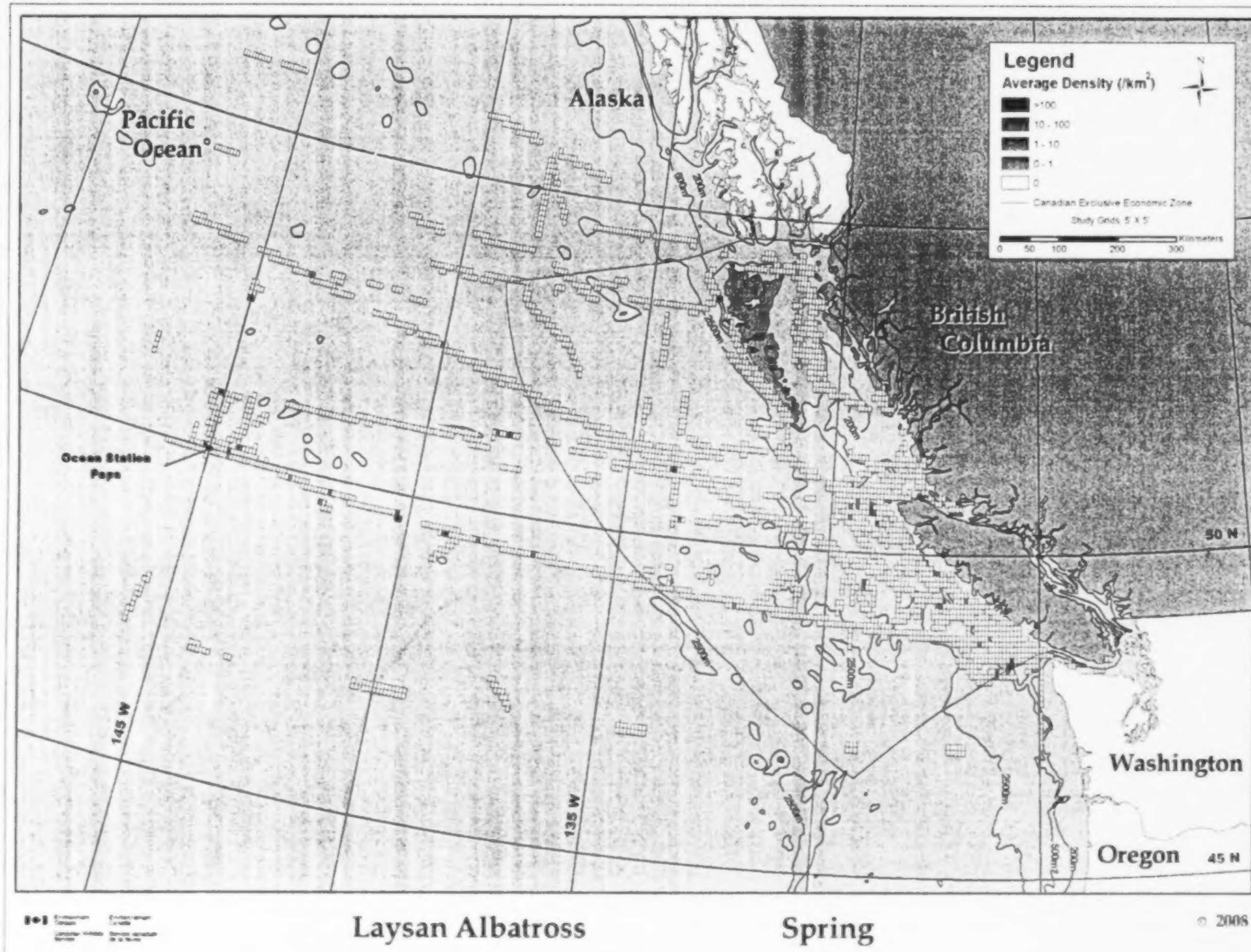


Figure 11A. Seasonal average grid cell densities of Laysan Albatrosses.

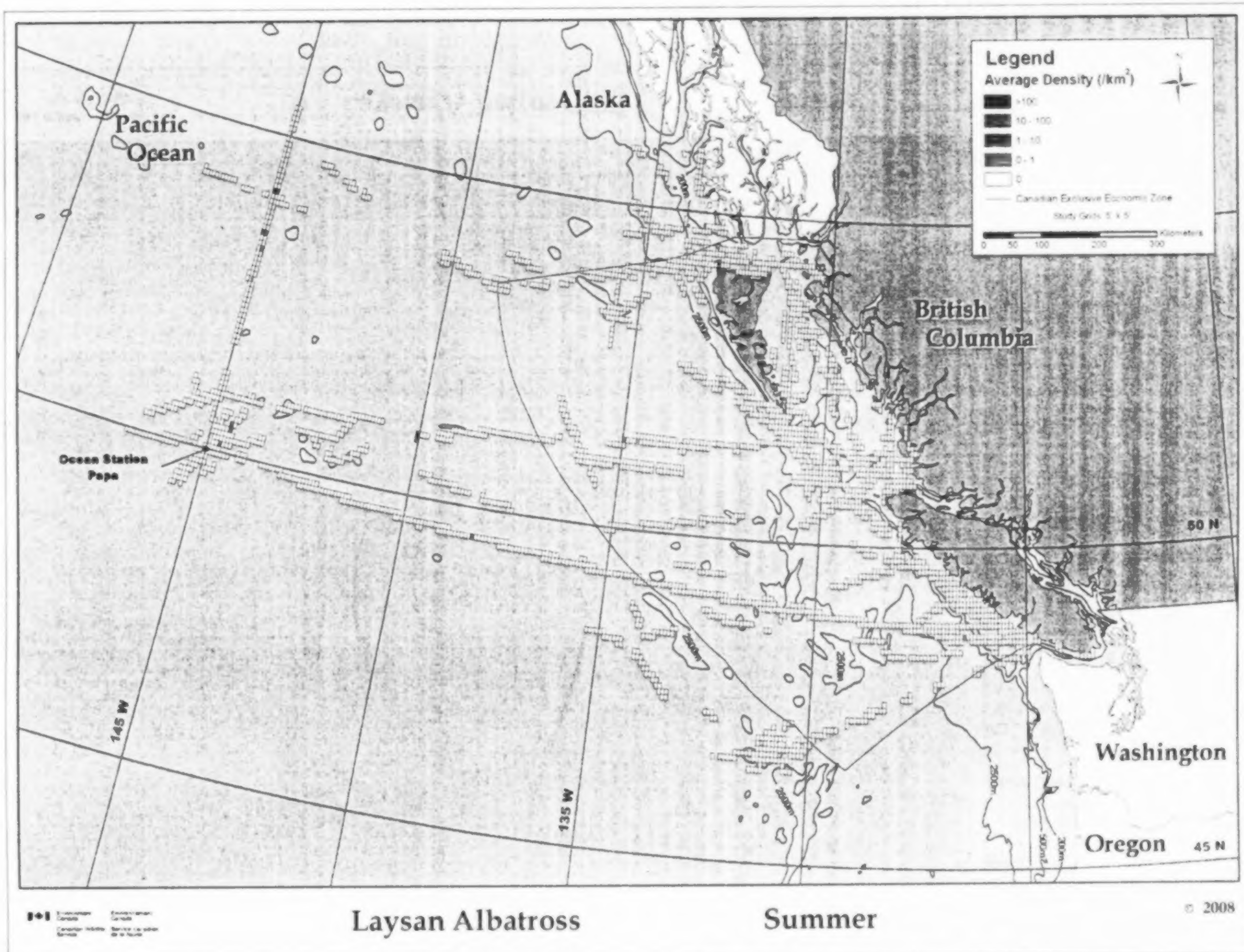


Figure 11B. Seasonal average grid cell densities of Laysan Albatrosses.

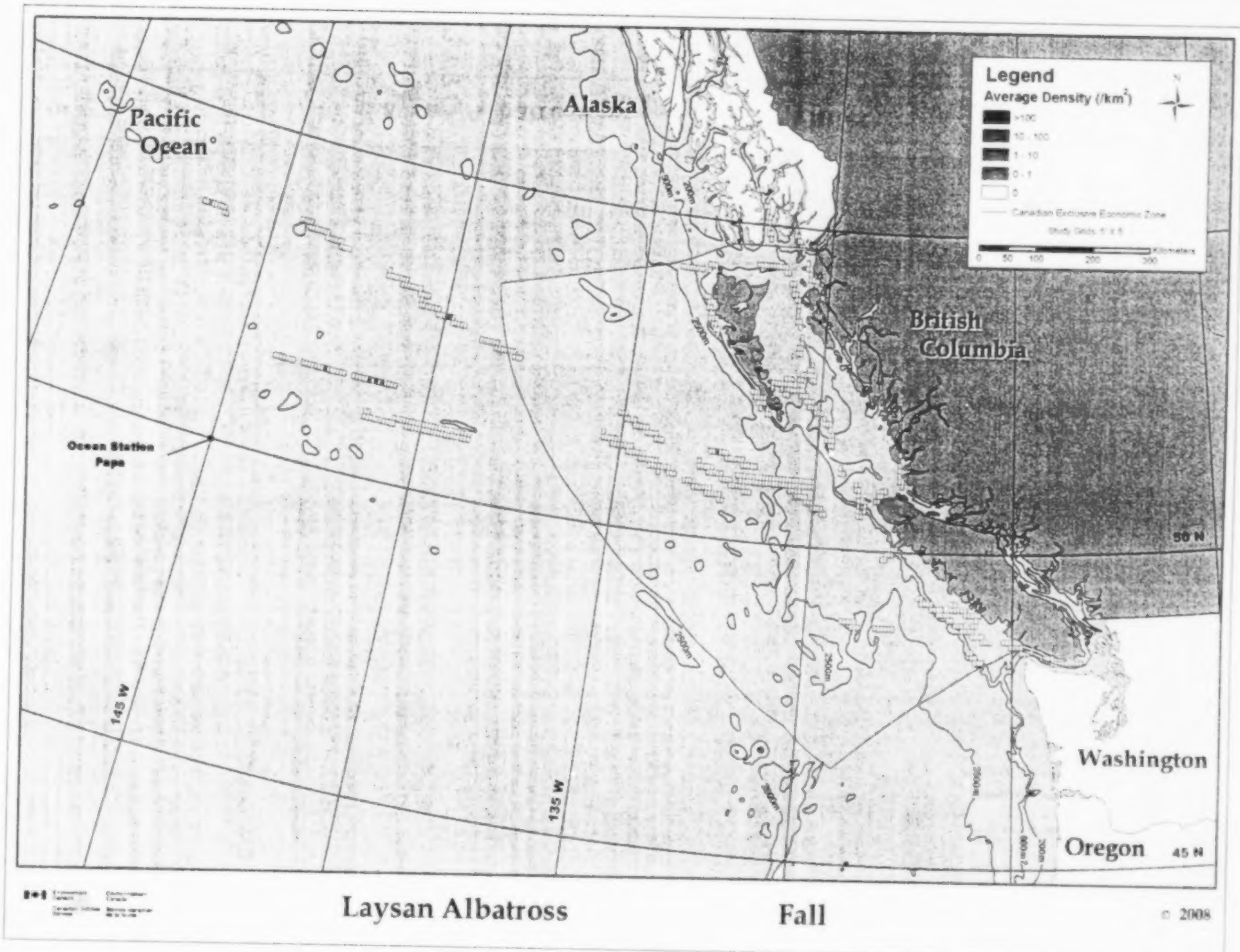


Figure 11C. Seasonal average grid cell densities of Laysan Albatrosses.

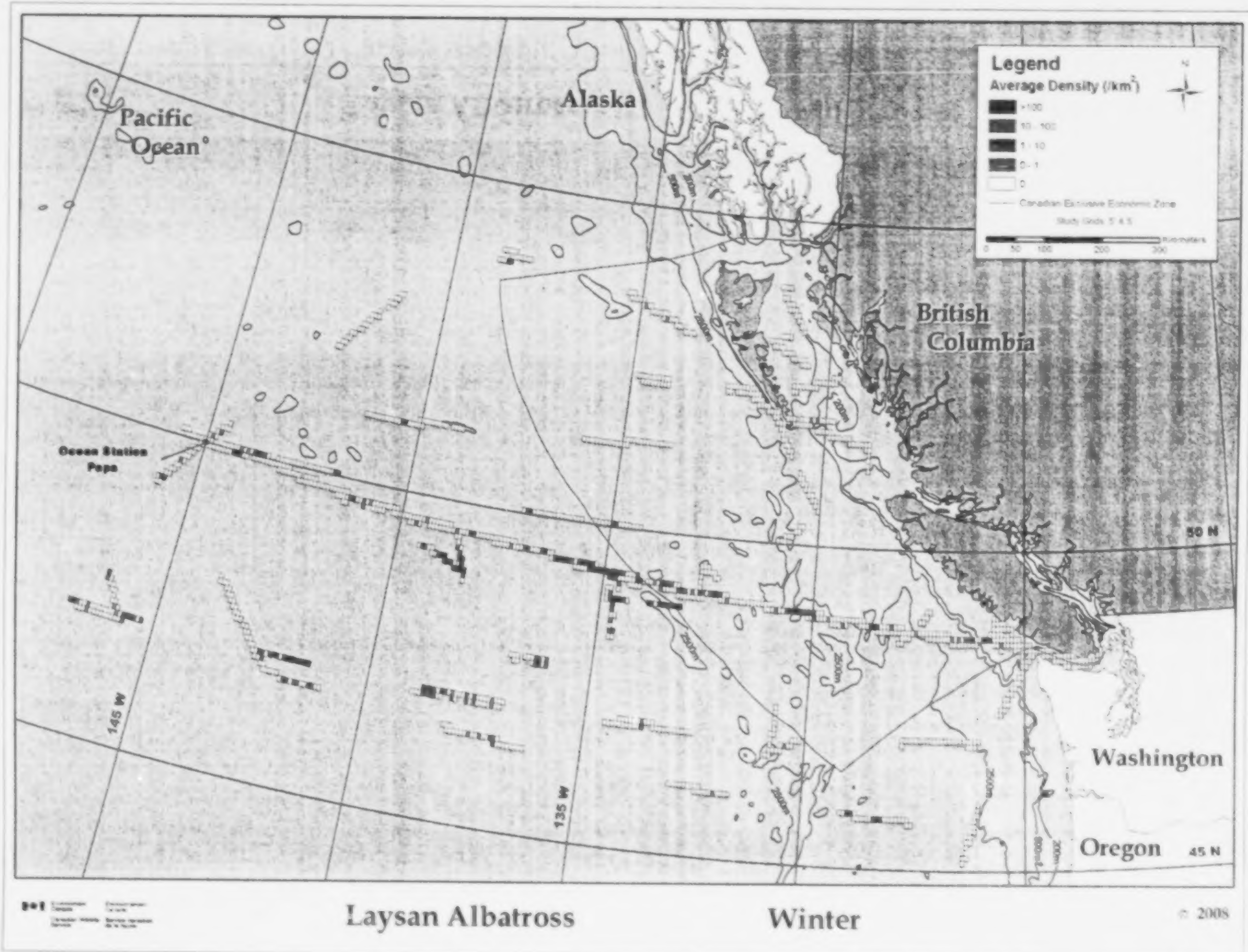


Figure 11D. Seasonal average grid cell densities of Laysan Albatrosses.

3.1.1.1 Laysan Albatross *Phoebastria immutabilis*

3.1.1.1.1 Population and Conservation Status

The global breeding population of Laysan Albatrosses is estimated at 874,000 birds. The IUCN listed the Laysan Albatross as globally *Vulnerable* (BirdLife International 2008), they are listed as *Vulnerable* by NatureServe (2008), and Kushlan *et al.* (2002) and Milko *et al.* (2003) list this as species of *High Conservation Concern* for N America and for Canada, respectively. Laysan Albatrosses nest on oceanic islands across the subtropical N Pacific.

3.1.1.1.2 Breeding Distribution and Chronology

The northwestern Hawaiian Islands, particularly Midway Atoll and Laysan Island, support >99% of the global breeding population (Rice and Kenyon 1962). In the 1970's, Laysan Albatrosses recolonized Torishima in the Japanese Ogasawara Islands (Hasegawa 1984), and during the 1980's the breeding range expanded into the eastern Pacific with the establishment of colonies on Isla Guadalupe, Islas Revillagigedos (Clarión and San Benedicto), and Rocas Alijos, Mexico (MX) (Pitman 1985, Pitman *et al.* 2004). Since 1996, a few pairs of Laysan Albatrosses have nested sporadically on Wake Atoll (central Pacific), a historical colony site. However, other than in 2001, no chicks are known to have fledged from that site (Rauzon *et al.* 2004). Most breeding Laysan Albatrosses arrive at the Hawaiian colonies around the beginning of November, a single egg is laid by late November or early December, chicks hatch between the end of January and mid-February, and by mid-July all fledglings have left the islands (Whittow 1993a).

3.1.1.1.3 Oceanic Distribution and Diet

Laysan Albatrosses range over most of the N Pacific, from the Bering Sea (approximately 62°N) and the Sea of Okhotsk south to the Hawaiian Islands (Fischer 2007). In the eastern and central N Pacific, the 'normal' southern boundary is most likely around 15°N (Sanger 1974). During the brooding period (i.e., the chick's first few days), Laysan Albatross parents from Hawaiian colonies will occasionally venture into the cool, productive N Pacific Transition Domain (15 to 12°C) and the Sub-Arctic Frontal Zone (12 to 10°C) waters; however, most forage over Tropical (>20°C) or Subtropical Frontal Zone (20 to 18°C) waters near their nesting islands (Hyrenbach *et al.* 2002). Many young Laysan Albatrosses spend their first summer between 40°N and 45°N from Japan east to at least 172°W (Wahl *et al.* 1989, Shaffer *et al.* in prep.). Gradually, over the next few summers the average center of the population of subadults shifts east-northeast to the adult summering area south of the Aleutian Islands (between 170° E and the International Date

Line, McDermond and Morgan 1993). Birds nesting on Guadalupe Island may commute as far as the west coast of Canada (R. Henry *et al.*, unpubl. data 2007).

Wahl *et al.* (2005) reported that Laysan Albatrosses have been observed off the WA coast in all months; but considered the species as an "uncommon winter visitor in offshore oceanic waters; irregularly rare to uncommon in summer". Laysan Albatrosses were present in the northern GOA in all months surveyed (March, April, May, October and December), but they were most common in December and May and least common in March and April. Birds were seen primarily at the shelfbreak and offshore in the Alaska Stream, but were regularly encountered inshore to the outer part of the middle shelf (Day 2006).

Laysan Albatrosses feed primarily upon squid (e.g., neon flying squid) and to a lesser extent on fish and invertebrates (Gould *et al.* 1997a) including jellyfish (e.g., *Velella velella*, Harrison *et al.* 1983). They feed by surface-seizing, contact-dipping and scavenging, most likely within 1 m of the water's surface (Brooke 2004).

3.1.1.1.4 Spatial Distribution and *Average Grid Cell Density* in Study Area

Campbell *et al.* (1990a) describe the Laysan Albatross as a very rare vagrant along the outer coast, with only 15 records spanning 24 February to 30 October. We found birds in all months in which surveys were conducted other than July; and most sightings of Laysan Albatrosses were far offshore. The exception was during spring; at which time, the species was more frequently encountered over the continental shelf.

Overall, the Laysan Albatross had somewhat of a restricted distribution and occurred at low densities during spring, summer, and fall; the corresponding seasonal maximum *average grid cell densities* were 0.5, 1.8 and 1.1 birds/km^2. In contrast, Laysan Albatrosses were commonly observed during winter, particularly in February; the maximum winter *average grid cell density* was 4.0 birds/km^2. Grid cells with the highest average winter densities were far offshore (i.e., the highest density occurred approximately 870 km west of Estevan Point). The relatively high number of Laysan Albatrosses in the study area during winter suggests that many of those birds were either subadults or non-breeding adults.

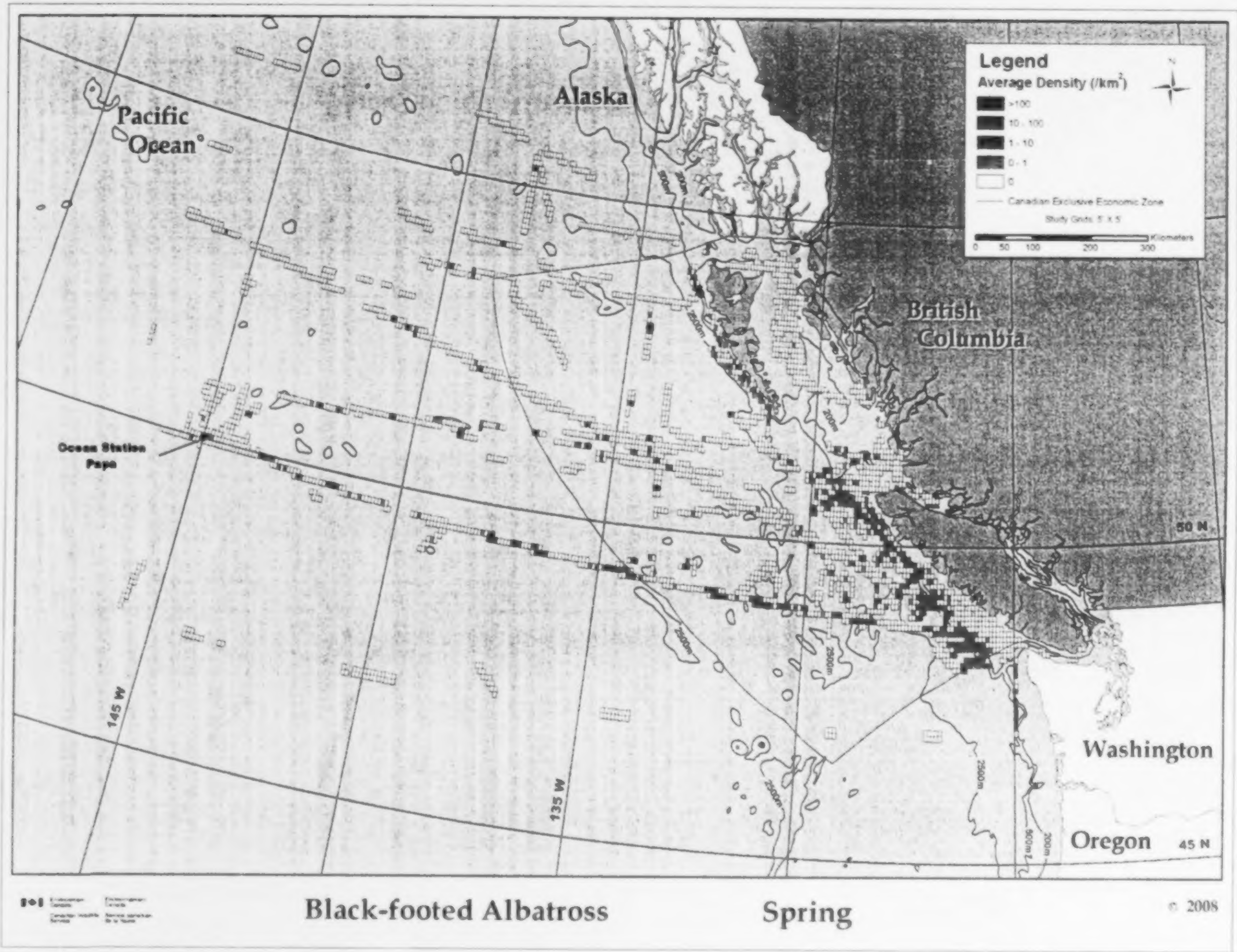


Figure 12A. Seasonal average grid cell densities of Black-footed Albatrosses.

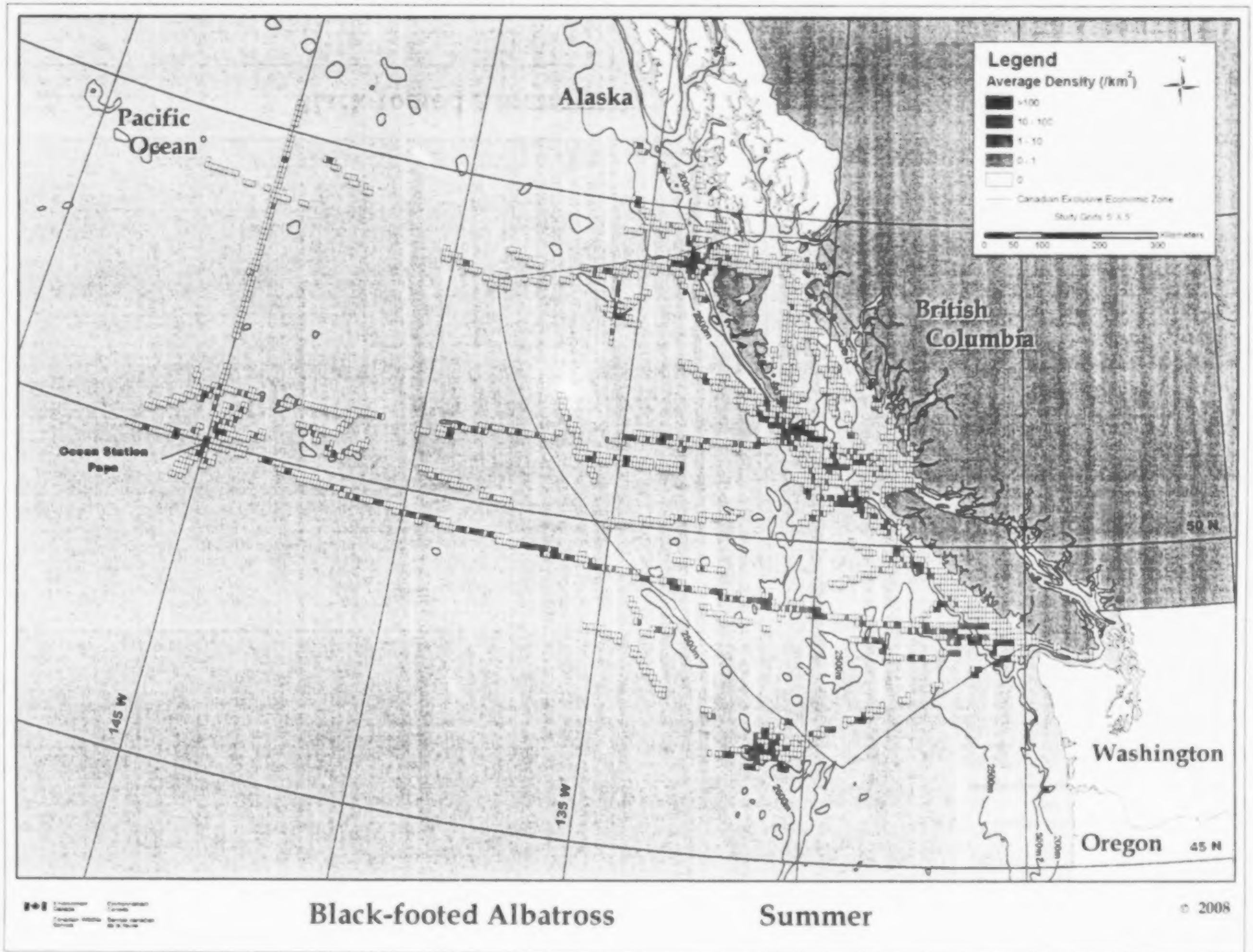


Figure 12B. Seasonal average grid cell densities of Black-footed Albatrosses.

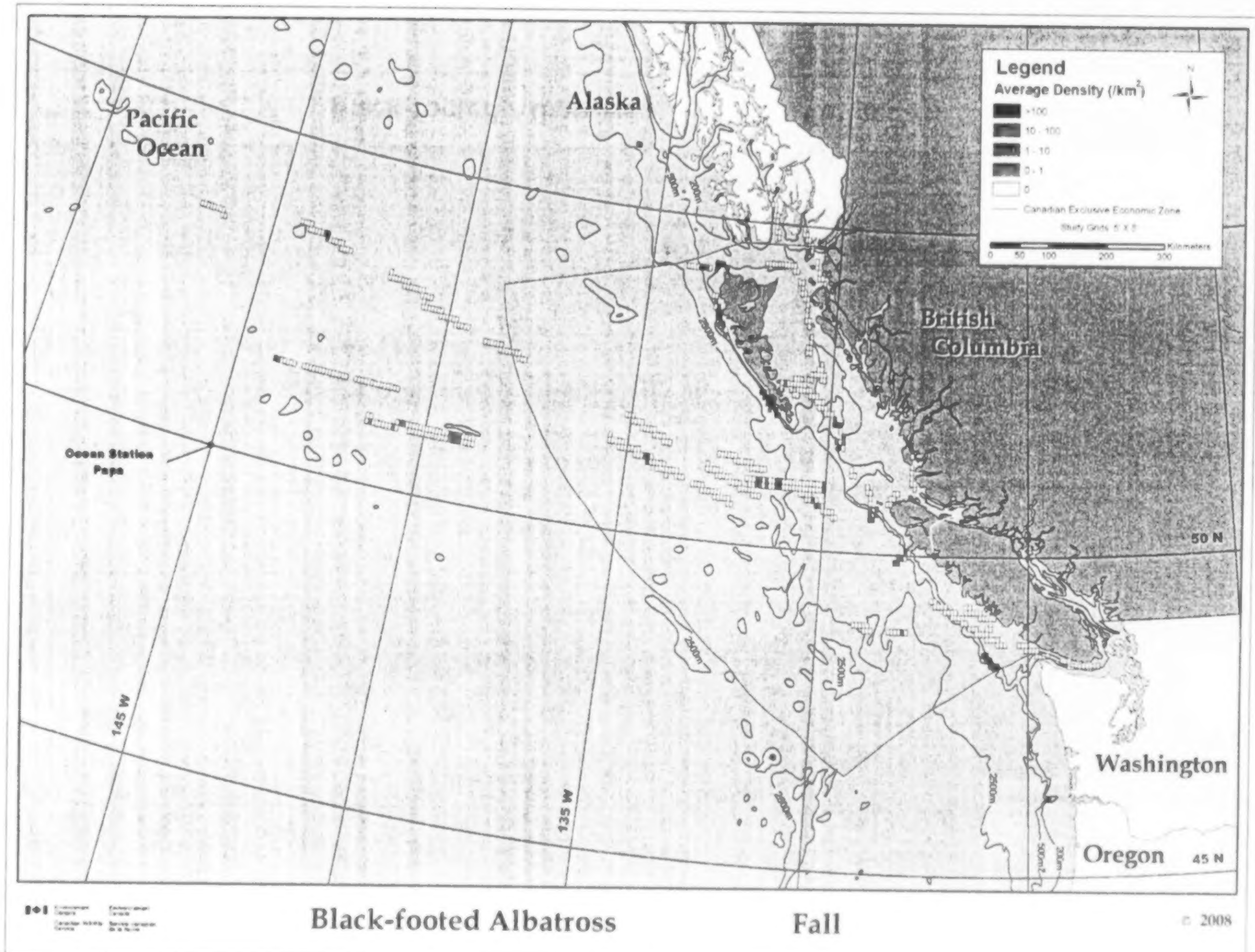


Figure 12C. Seasonal average grid cell densities of Black-footed Albatrosses.

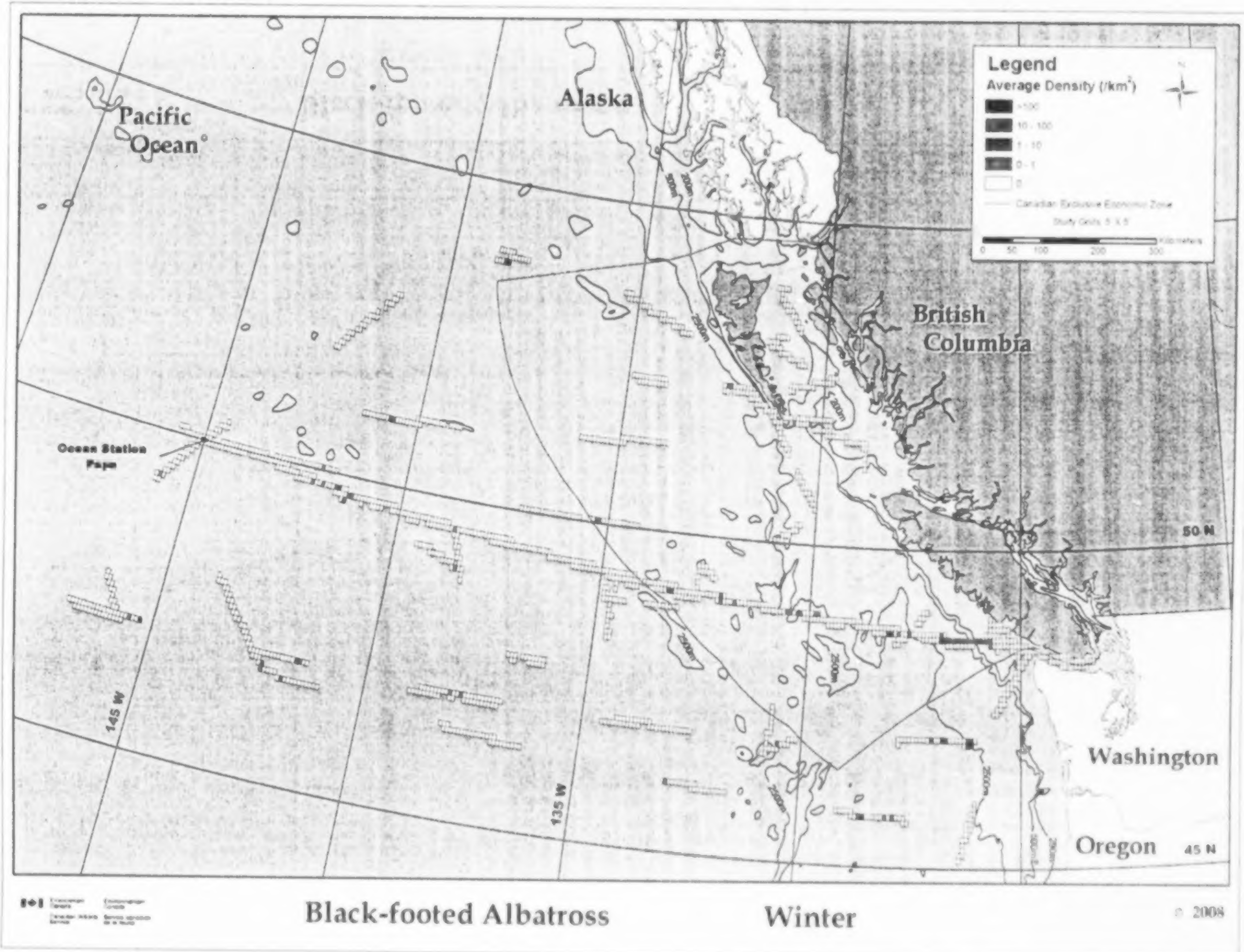


Figure 12D. Seasonal average grid cell densities of Black-footed Albatrosses.

3.1.1.2 Black-footed Albatross *Phoebastria nigripes*

3.1.1.2.1 Population and Conservation Status

Globally, the Black-footed Albatross is listed as *Endangered* by the IUCN (BirdLife International 2008), as *Highly Imperilled* in N America and Canada (Kushlan *et al.* 2002, Milko *et al.* 2003), and in April 2007, it was designated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as a species of *Special Concern* in Canada (COSEWIC 2006). There is considerable variation in the estimated global population of the Black-footed Albatross; it may be as low as 200,000 individuals (Whittow 1993b) or as high as 300,000 birds (Cousins and Cooper 2000).

3.1.1.2.2 Breeding Distribution and Chronology

The Black-footed Albatross nests on oceanic islands across the tropical/subtropical N Pacific, with the northwestern Hawaiian Islands supporting approximately 95% of the global breeding population. Other colonies are located in the Izu and Ogasawara Islands of Japan and on the Senkaku Islands (Hasegawa 1984, Tickell 2000). Although individual pairs have attempted to breed at Wake Atoll since 1996, none have successfully fledged young (Rauzon *et al.* 2004. The breeding range of this species also includes the eastern N Pacific, individual pairs have bred on the Mexican islands of Guadalupe (1998) and San Benedicto (2000) (Pitman and Ballance 2002). Black-footed Albatrosses have also recently bred on Guadalupe and San Benedicto Islands of MX (Pitman and Ballance 2002). Most breeders return to the Hawaiian colonies in mid- to late October, laying a single egg between mid-November and early December; Fledging begins in mid-June and by the third week of July all fledglings have left the colonies (Whittow 1993b).

3.1.1.2.3 Oceanic Distribution and Diet

For a generalized summary of the seasonal at-sea distribution of Black-footed Albatrosses in the N Pacific, see McDermond and Morgan (1993). During the brooding period, breeding Black-footed Albatrosses generally restrict their foraging to Tropical waters (>20°C) (Fischer 2007). However, later during the chick-rearing phase, many Black-footed Albatrosses will commute as far as the productive waters of the California Current System (from California [CA] to BC) to forage for their chicks (Hyrenbach *et al.* 2002, M.. Kappes *et al*, unpubl. data 2007).

In Washington (WA), Black-footed Albatrosses are described as "*seasonally uncommon to common year-round visitor in oceanic waters*". They have occurred there in all months, with the highest number of observations between late April and mid-October (Wahl *et al.* 2005). Sanger

(1970) indicated that Black-footed Albatrosses were present in WA and Oregon (OR) in nearshore and offshore areas year-round, but had restricted distribution and abundance during winter. Of the more than 30,000 Black-footed Albatrosses observed off the northwest coast of WA between 1971 and 2000, only 7% were found over waters shallower than 100 m (Wahl *et al.* 2005).

Rintoul *et al.* (unpubl. 2006) reported that Black-footed Albatrosses were far more common off central CA (Gulf of the Farallones) than off Southern CA (California Bight region), and that the highest densities of albatrosses occurred over the shelfbreak/upper slope region. Briggs *et al.* (1987) estimated that there were between 15,000 and 75,000 Black-footed Albatrosses off the CA coast in early summer, whereas between October and March, only an estimated 500 to 1,500 birds were present.

Black-footed Albatrosses were encountered in the northern GOA during each cruise undertaken (March, April, May, October and December) but were least numerous in December and March. Most occurred at the shelfbreak and offshore, but were routinely encountered over the middle shelf (Day 2006).

Black-footed Albatrosses feed upon fish (e.g., rockfish species), flying fish eggs, squid (e.g., neon flying squid), mysids, isopods, and offal (Harrison *et al.* 1983, Brooke 2004). Food is captured by surface-seizing, contact dipping, and scavenging, primarily within 1 m of the sea surface (Brooke 2004).

3.1.1.2.4 Spatial Distribution and *Average Grid Cell Density* in Study Area

Within the study area, Black-footed Albatrosses were observed in nearshore and offshore areas year-round. During spring and summer, most birds occurred above or seaward of the shelfbreak consistent with reports by Vermeer *et al.* (1987a). The concentration of Black-footed Albatrosses on the outer shelf and over the shelfbreak may in part be due to the distribution of the fishing fleets (Wahl and Heinemann 1979, Vermeer *et al.* 1989, Hyrenbach 2001). In addition, Black-footed Albatrosses occurred at higher densities over some of the offshore seamounts (e.g., Cobb Seamount). Haney *et al.* (1995) similarly found elevated numbers of Black-footed Albatross over a deep N Pacific seamount, approximately 980 km west of southern CA.

In spring, the highest *average grid cell densities* occurred along the upper slope west of Hippa Island; along the west coasts of Moresby Island (QCI), Vancouver Island and WA; and over Union Seamount. The highest spring *average grid cell density* was 15.0 birds/km^2. Black-footed

Albatrosses were normally observed as individuals or in small groups. In marked contrast, a large but dispersed gathering of 117 birds was observed, over three consecutive transects, on 7 June 1995 approximately 35 km northwest of Hippa Island.

The highest summer *average grid cell densities* of Black-footed Albatrosses (between 10.0 and 14.0 birds/km^2) occurred at the edge of the shelf southwest of Barkley Sound and approximately 30 km southeast of Cape St. James. These high *average grid cell densities* were likely the result of encountering two large flocks; one of 37 birds (seen 8 August 1991 off Barkley Sound), and another of 45 birds (observed on 8 September 2002) off Cape St. James. Other than these large groupings, the majority of Black-footed Albatross summer observations were of either single birds or small flocks.

Fall Black-footed Albatross *average grid cell densities* were similar to those observed in spring and summer. Most birds occurred along the shelfbreak just west of the QCI and west of Cape Flattery. With the exception of a single intermediate sized flock, all fall observations were of six or less birds; the exception was a group of 18 birds found (on 20 September 2005) at the edge of the shelf southwest of Moresby Island.

Winter densities of Black-footed Albatrosses were predominantly low; the highest *average grid cell density* was 1.2 birds/km^2. Although a few Black-footed Albatrosses were observed over the shelf, most were encountered over deep, offshore waters. This distribution 'pattern' may have been in part due to the fact that there was considerably more survey effort offshore than over the shelf during winter.

According to Campbell *et al.* (1990a) Black-footed Albatrosses are a fairly common visitor from spring to early fall along the outer coast, and uncommon during the rest of the year. Although present in all months, >75% of all sightings reported by Campbell *et al.* (1990a) occurred during May through August. This pattern not only reflects the breeding cycle of the species, but also reflects the seasonality of birdwatchers out at sea, as well as better observing conditions at that time of the year.

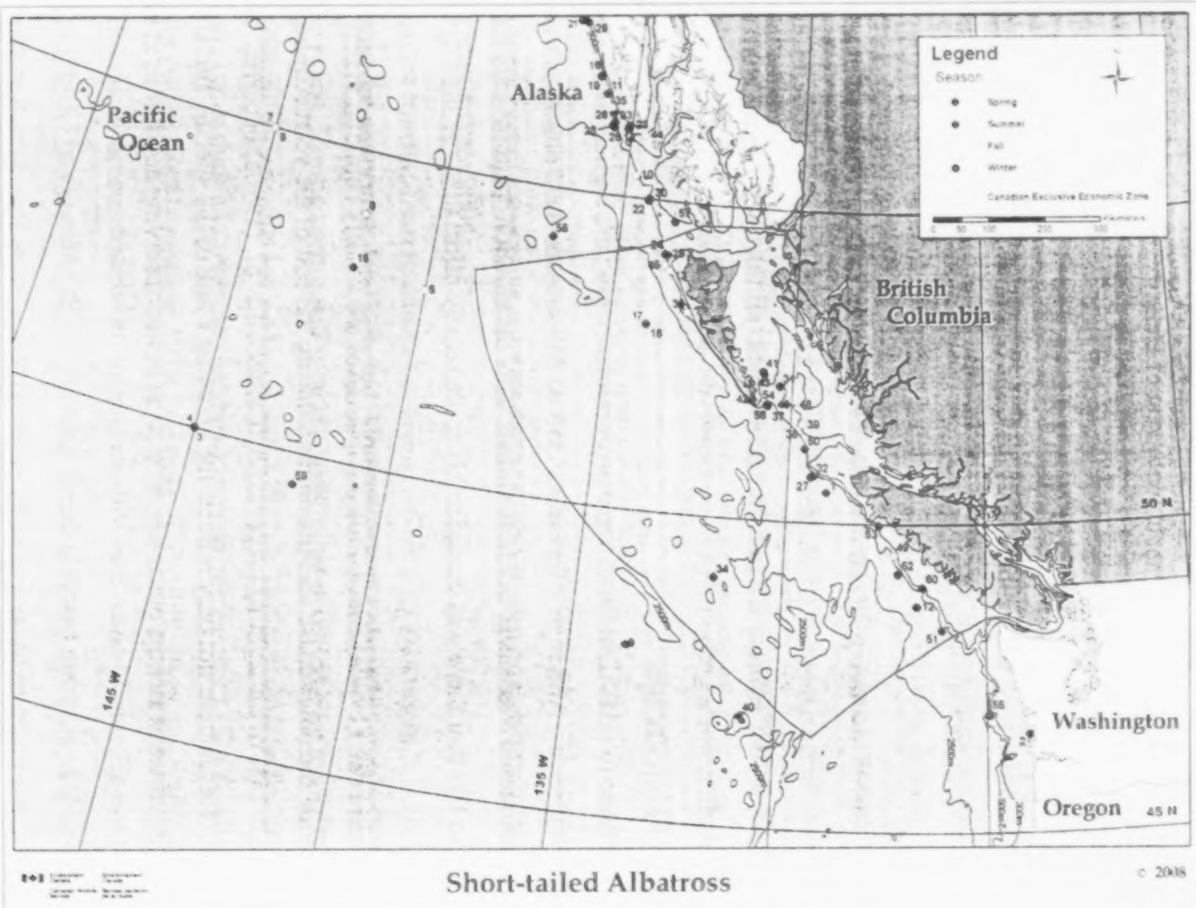


Figure 13. Locations where Short-tailed Albatrosses have been observed.

See Appendix 1 for details.

3.1.1.3 Short-tailed Albatross *Phoebastria albatrus*

3.1.1.3.1 Population and Conservation Status

The IUCN lists the Short-tailed Albatross as globally *Vulnerable* (BirdLife International 2008), they are listed as *Vulnerable* by NatureServe (2008), and Kushlan *et al*. (2002) and Milko *et al*. (2003) list it as a species of *High Conservation Concern* for N America and for Canada. In November 2003, the species was designated by COSEWIC as *Threatened* in Canada (COSEWIC 2003). It is estimated that the global population of Short-tailed Albatrosses is approximately 2,650 individuals (G. Balogh, pers. comm.).

3.1.1.3.2 Breeding Distribution and Chronology

Short-tailed Albatrosses breed on only three islands in Japan; most (approx. 85%) nest in two colonies on Torishima Island. The remaining birds nest on Minami-kojima Island and in 2002, one Short-tailed chick fledged from Kita-kojima Island (Hasegawa 2002); both islands are part of the Senkaku Island chain.

Most breeders arrive at Torishima Island in early October, nesting commences in late October and fledglings depart between late May and the end of June (Hasegawa and DeGange 1982).

3.1.1.3.3 Oceanic Distribution and Diet

For a generalized summary of the seasonal at-sea distribution of Short-tailed Albatrosses in the N Pacific, see Hasegawa and DeGange (1982) and McDermond and Morgan (1993).

Throughout most of the GOA Short-tailed Albatrosses appear to prefer the shelfbreak/upper slope regions. Piatt *et al.* (2006) noted that the species consistently occurred along the shelfbreak near the Aleutian Islands and suggested that the birds were keying in on specific and predictable oceanographic features, such as areas with strong vertical mixing.

The majority of birds seen in the GOA are juvenile birds, suggesting age-related spatial separation (McDermond and Morgan 1993, Suryan *et al*. 2006, 2007).

The diet of the Short-tailed Albatross is poorly known; but it is considered to consist primarily of crustaceans, fish, squid (e.g., Japanese common squid) and offal (Hasegawa and DeGange 1982, Tickell 2000).

3.1.1.3.4 Distribution in Study Area

Although a relatively rare species to Canada's west coast EEZ, Short-tailed Albatrosses were encountered in the study area in all months other than December (recall December was the only

month with no survey effort). Approximately 85% of the sightings took place between May and November (Appendix 1).

Similar to that noted for the GOA (McDermond and Morgan 1993, Suryan *et al*. 2006, 2007) the majority of birds seen in the study area were juvenile or immature birds. Most of the albatrosses were encountered over the shelfbreak/upper slope regions; and there were many sightings from relatively confined areas, such as off the southern coast of Moresby Island and along the shelfbreak west of Graham Island (QCI).

Campbell *et al.* (1990a) considers the species' current status in BC waters as uncertain and accidental. However, this study shows that in fact, the Short-tailed Albatross is an uncommon, but regular visitor to west coast Canadian waters. From our own data and what we were able to assemble from other sources, there have been 30 sightings of Short-tailed Albatrosses within the Canadian EEZ and all but one have been since 1996. Barring any major calamity at their breeding colonies, Short-tailed Albatrosses will most likely become a relatively common visitor to the study area in the future.

3.1.2 Fulmars

Northern Fulmar (*Fulmarus glacialis*).
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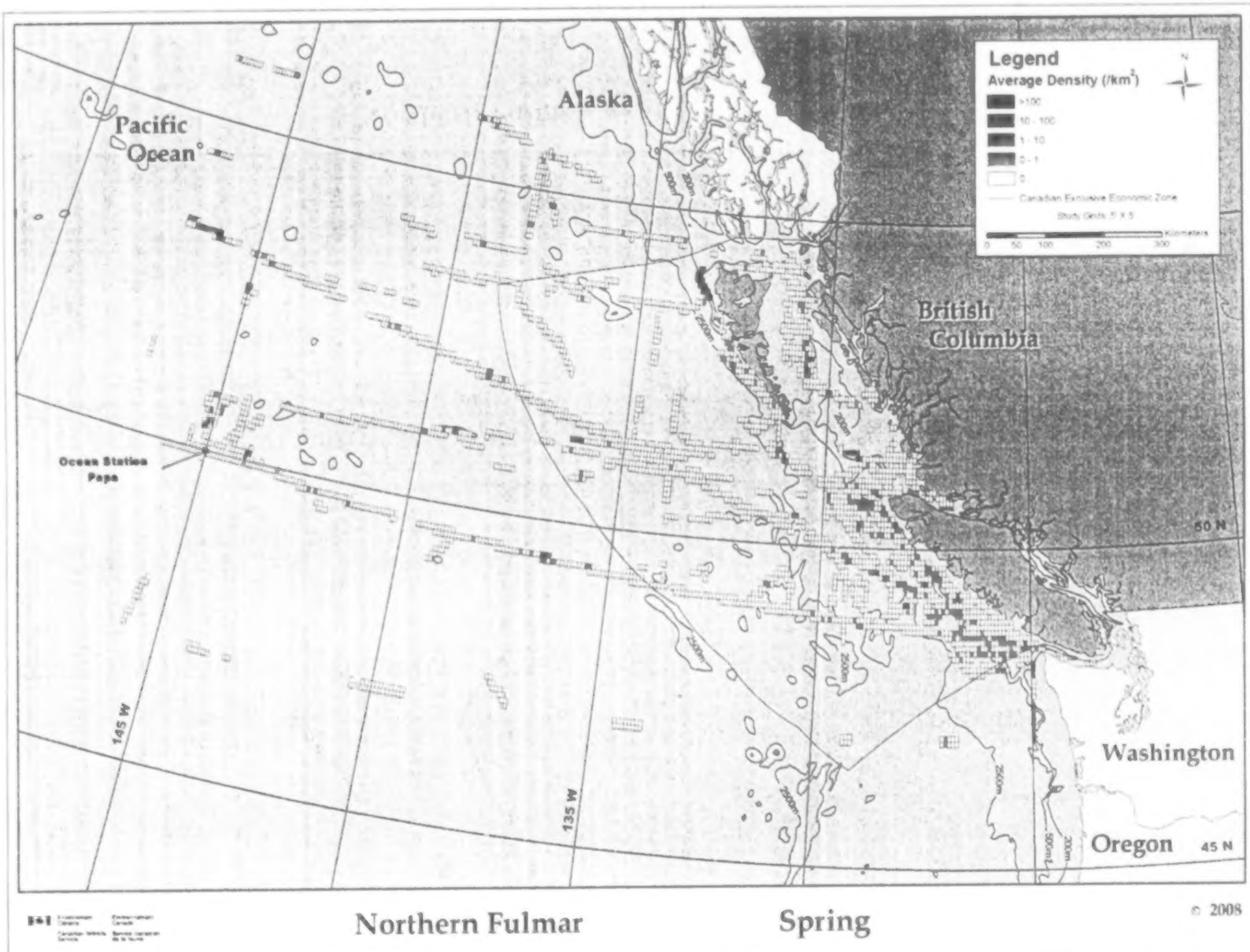


Figure 14A. Seasonal average grid cell densities of Northern Fulmars.

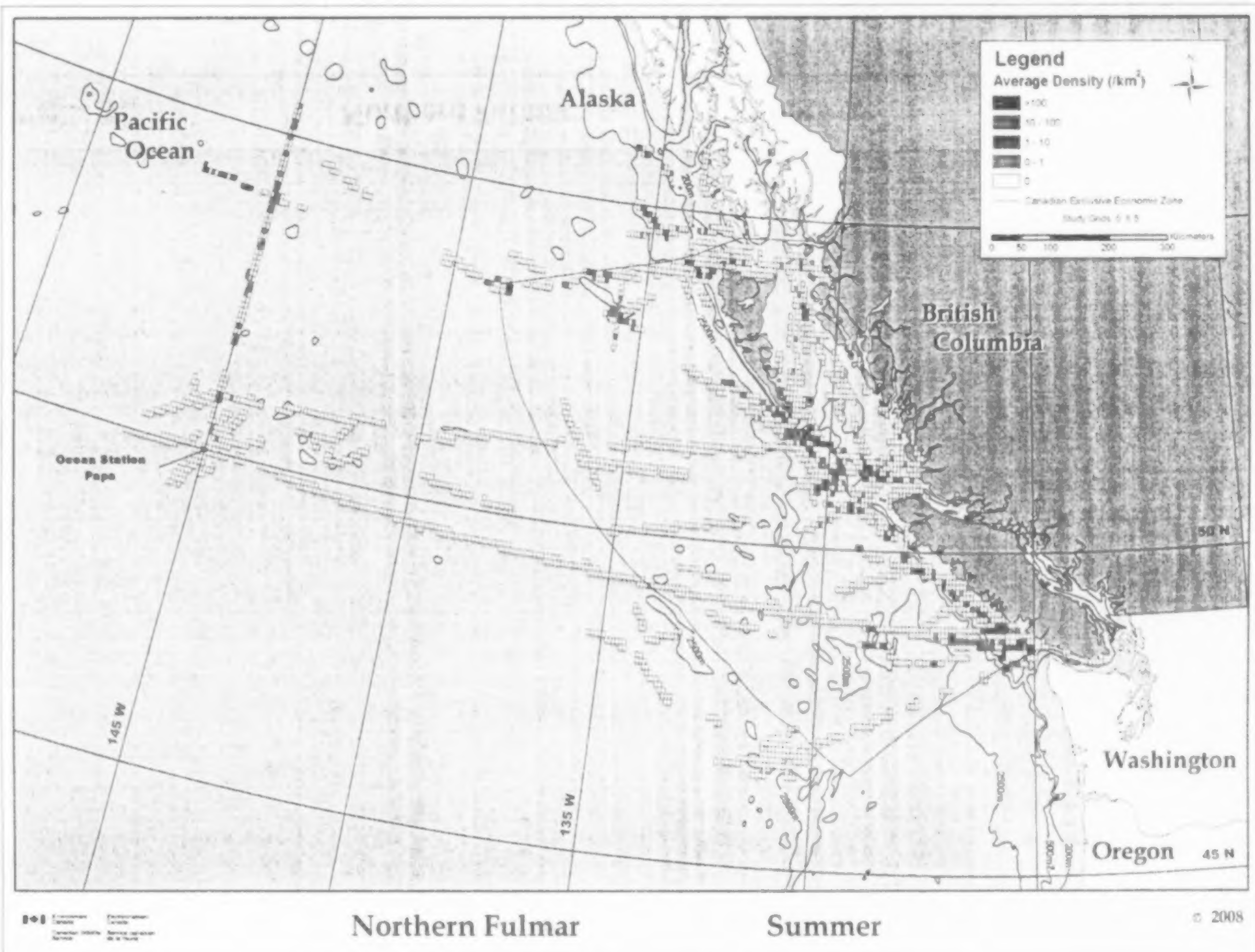


Figure 14B. Seasonal average grid cell densities of Northern Fulmars.

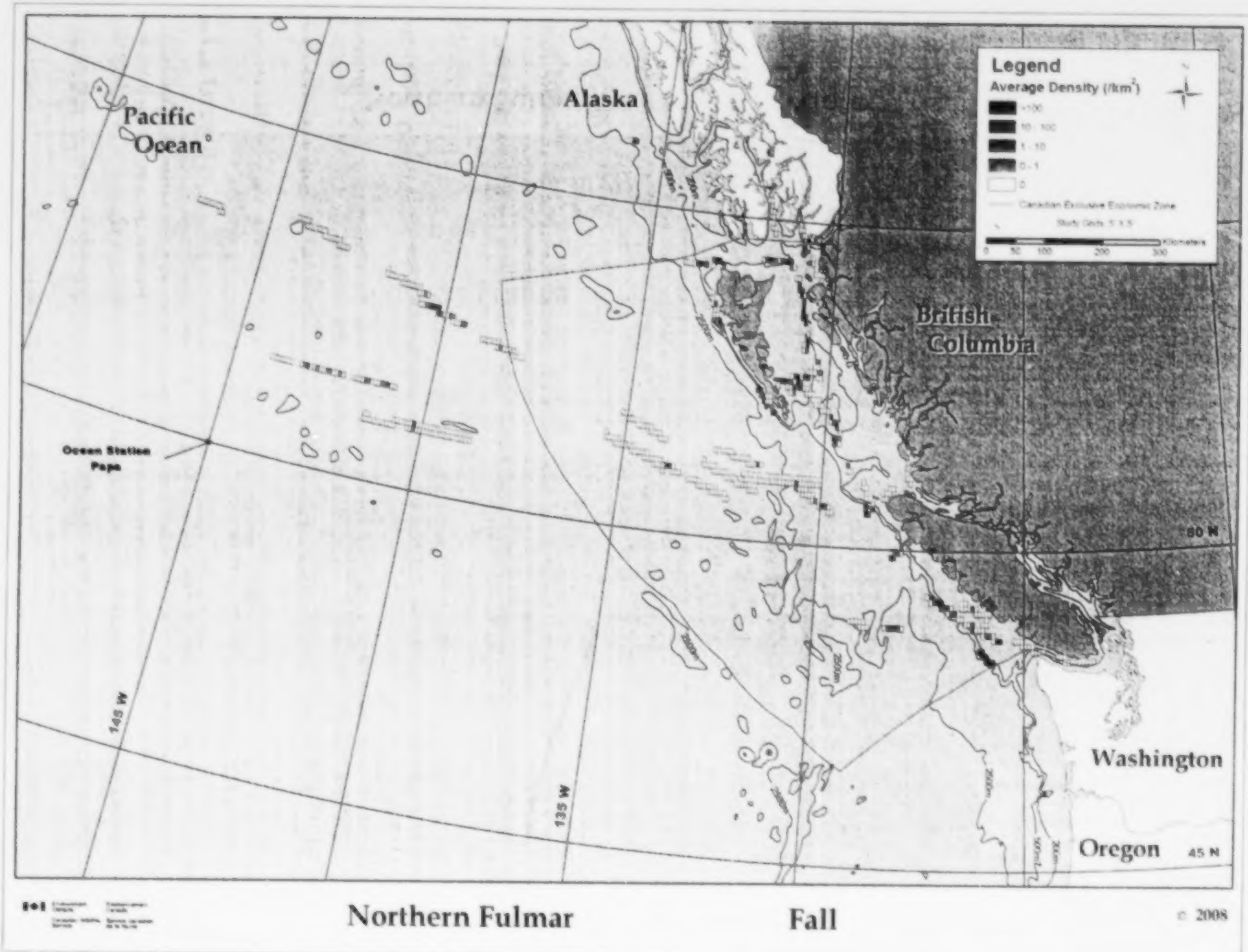


Figure 14C. Seasonal average grid cell densities of Northern Fulmars.

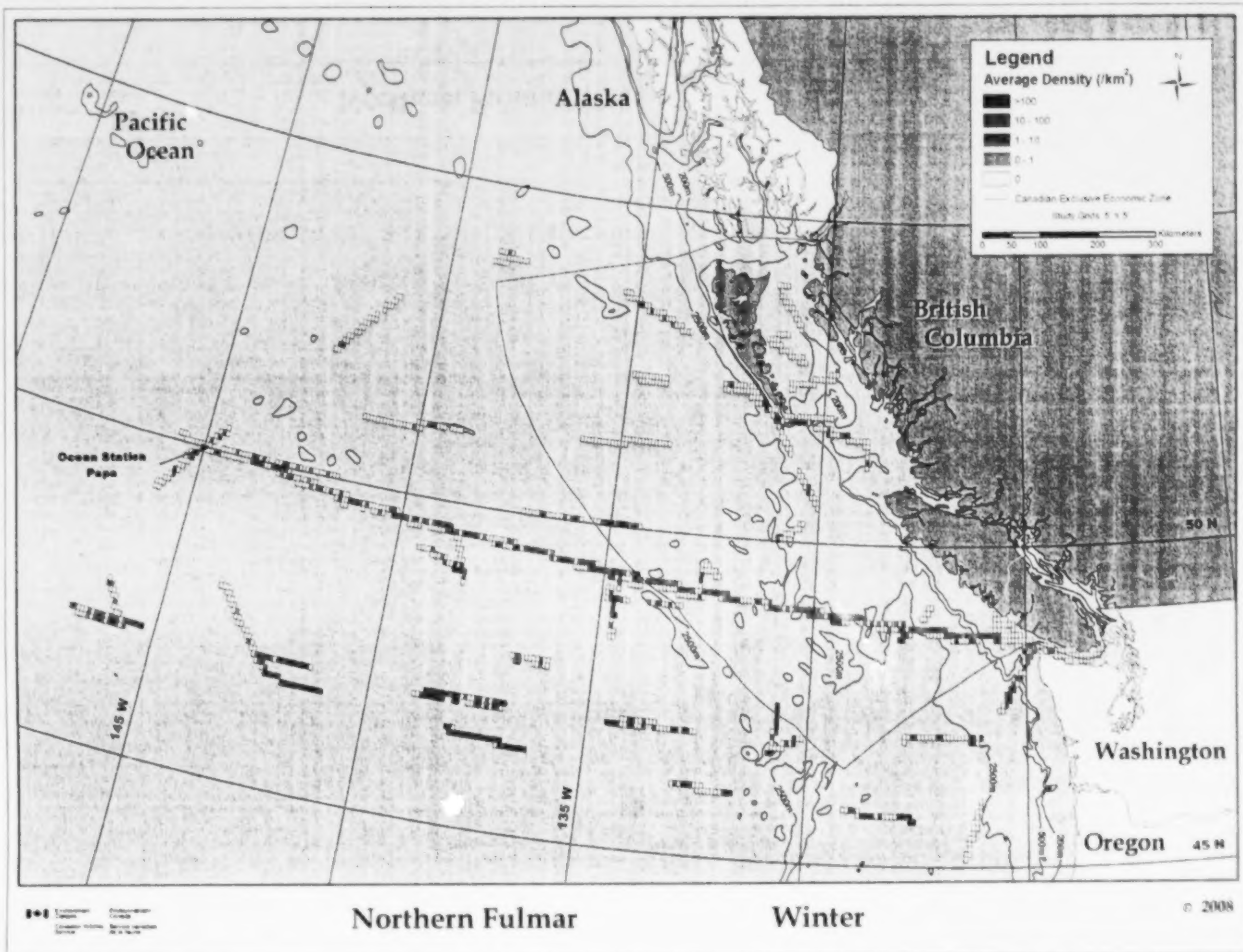


Figure 14D. Seasonal average grid cell densities of Northern Fulmars.

3.1.2.1 Northern Fulmar *Fulmarus glacialis*

3.1.2.1.1 Population and Conservation Status

The Northern Fulmar is the only breeding species of the family *Procellariidae* in the sub-Arctic N Pacific. The global abundance is estimated between eight and 32 million birds, with approximately 1.4 million breeding at colonies in the eastern N Pacific (Hatch and Nettleship 1998, BirdLife International 2008). Worldwide, Northern Fulmar populations are considered secure, and are ranked by the IUCN as a species of *Least Concern* (BirdLife International 2008). They are listed as *Secure* by NatureServe (2008), and Milko *et al.* (2003) categorize the species as *Not Currently at Risk* in Canada; in contrast, Kushlan *et al.* (2002) ranked the Northern Fulmar as a species of *Moderate Conservation Concern* for N America. The Northern Fulmar is on BC's *Red List* (i.e., indigenous species and subspecies that have been extirpated, or are endangered or threatened in BC) because of their critically imperilled provincial breeding population (BCCDC 2006).

3.1.2.1.2 Breeding Distribution and Chronology

The Northern Fulmar breeds discontinuously in polar and sub-polar regions throughout most of the N Hemisphere; and they occur in large numbers in the N Pacific, the N Atlantic, and Arctic waters. In the N Pacific, fulmar colonies occur along the coasts of Alaska (AK), the Aleutian and Pribilof Islands, and along the Bering Sea; and in Russia, on the Kuril and Commander Islands, and along the coasts of the Bering Sea, the Sea of Okhotsk, and the Chukchi Peninsula (Hatch and Nettleship 1998). Since the mid-1970's, Northern Fulmars were suspected of nesting in BC, and in 1979, nesting on Triangle Island was confirmed (Campbell *et al.* 2001).

Depending on the colony location, Northern Fulmars begin nesting from early May through June. A single egg is incubated for 46-51 days, and most chicks have fledged by the end of August (some as late as early October) (Hatch and Nettleship 1998).

3.1.2.1.3 Oceanic Distribution and Diet

The Northern Fulmar is a widespread, fairly common to abundant visitor to the continental shelf and offshore areas in WA; they have been reported in all months, with higher numbers between July and mid-November (Wahl *et al.* 2005). Briggs *et al.* (1987) observed that Northern Fulmars were present in CA waters all year long with large numbers occurring only between October and March or April.

Like all *Procellariidae*, Northern Fulmars are highly pelagic, spending most of the annual cycle at sea. Wahl *et al.* (2005) noted that off WA >95% of Northern Fulmars were found over depths between 100 and 1,000 m. They are known to forage in areas of strong upwellings, currents and eddies, and in mixed-species groups with other species of seabirds (Briggs *et al.* 1987). This species is strongly attracted to vessels, particularly fish boats, and thus their distribution is highly affected by the locations of the fishing fleets (Wahl and Heinemann 1979, Vermeer *et al.* 1989). Northern Fulmars are surface feeders, picking prey from, or making short dives below, the ocean's surface; their diet includes fish (cod, pollock, Pacific sandlance, Pacific herring, and rockfish species), and invertebrates (Hatch and Nettleship 1998). Also prevalent in the diet are discarded offal and baits stolen from commercial longline hooks. Fulmar chicks are fed regurgitated food, therefore it is assumed that adult and chick diets are similar during the breeding season (Hatch and Nettleship 1998). The tendency for fulmars to attend fishing vessels could lead to a conservation concern. Melvin *et al.* (2006) noted that between 1993 and 2004, the incidental take of seabirds in the Alaskan groundfish longline fisheries averaged over 13,000 birds per year; and that Northern Fulmars made up >57% of all birds taken.

3.1.2.1.4 Spatial Distribution and *Average Grid Cell Density* in Study Area

This species was observed year-round in the study area, commonly over the shelfbreak and in offshore waters. In spring, fulmars were encountered along the outer shelf, from Grays Harbor (WA), north along the shelf off Vancouver Island to Cape Scott. Low *average grid cell densities* of Northern Fulmars (0.1-1.0 birds/km^2) occurred in Queen Charlotte and Hecate Straits, and moderate densities (1.0-10.0 birds/km^2) occurred within 20 km of the northwest coast of Graham Island (especially near Frederick and Langara Islands). Within the study area, our most northern observation of fulmars was approximately 700 km west of Kruzof Island (AK). To the south of there, Northern Fulmars were encountered out to almost 1,000 km from the nearest land. Highest spring densities (15.7 and 25.9 birds/km^2) were respectively, along the shelfbreak roughly 65 km west of Grays Harbor and 15 km west of the Olympic Peninsula. The largest group of Northern Fulmars encountered during spring (140 birds) was encountered off the Olympic Peninsula (on 2 June 1999).

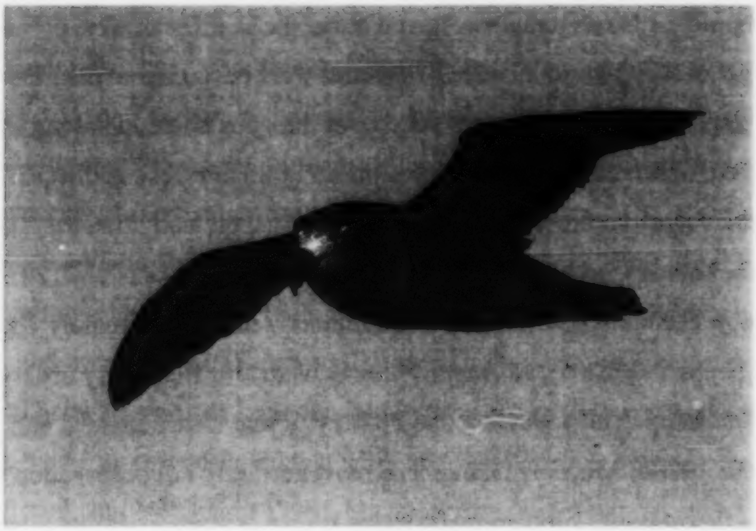
The highest Northern Fulmar *average grid cell density* occurred during summer (118.1 birds/km^2), a result of encountering a group of 450 birds (on 1 September 2001) about 30 km southwest of Amphitrite Point. Similar to that reported previously by Morgan *et al.* (1991),

highest summer densities of fulmars occurred over La Perouse, Amphitrite, and Swiftsure Banks. Concentrations of Northern Fulmars occurred along the shelfbreak west of Vancouver Island and west of Langara Island. Low to moderate densities were encountered over Bowie Seamount. Although the majority of fulmars were found over the outer shelf and along the shelfbreak/upper slope, many were observed well offshore to almost 1,000 km west of the QCI.

Northern Fulmars were common during fall surveys, inshore and offshore. The highest fall *average grid cell density* occurred in Hecate Strait, west of Banks Island (20.9 birds/km^2). The largest fall group encountered consisted of 66 fulmars seen approximately 7 km west of Banks Island (on 22 September 2005). Northern Fulmars were also frequently observed along the edge of the shelf from Cape Scott south to Cape Flattery. There were scattered encounters between 400 and 700 km west of Moresby Island. The most northerly fall observation was of a single bird seen roughly 110 km west of Iphigenia Bay (AK).

During winter, the overall density of Northern Fulmars was low to moderate; highest densities tended to occur well offshore. Although there was considerably fewer surveys north of 52° N, most fulmars at this time of the year were seen in the southern sub-regions. Our most northerly winter record was from approximately 355 km west of Langara Island. Similar to the fall situation, most Northern Fulmars occurred in winter as singles or in pairs; the largest group encountered consisted of 10 birds seen near OSP (on 24 January 1982). Campbell *et al.* (1990a) reported that Northern Fulmars have been observed in BC in every month, and are likely a common visitor offshore in winter, fairly common at other times and locally abundant.

3.1.3 Petrels



Solander's Petrel (*Pterodroma solandri*).
© Ben Lascelles, BirdLife International.

Also known as Gadfly petrels, species in the genus *Pterodroma* are common in the Pacific Ocean, particularly in tropical regions (Harrison 1983). Two species of *Pterodroma* (Mottled Petrel and Murphy's Petrel) were regularly observed within the study area. Three additional species (Cook's, Herald, and Solander's Petrels) and a species pair referred to as 'Dark-rumped' Petrels (either Hawaiian or Galapagos) were also reported from the study area. Information on the latter four species/species pair is presented in section 3.4 (Unconfirmed/Hypothetical Rare Species).

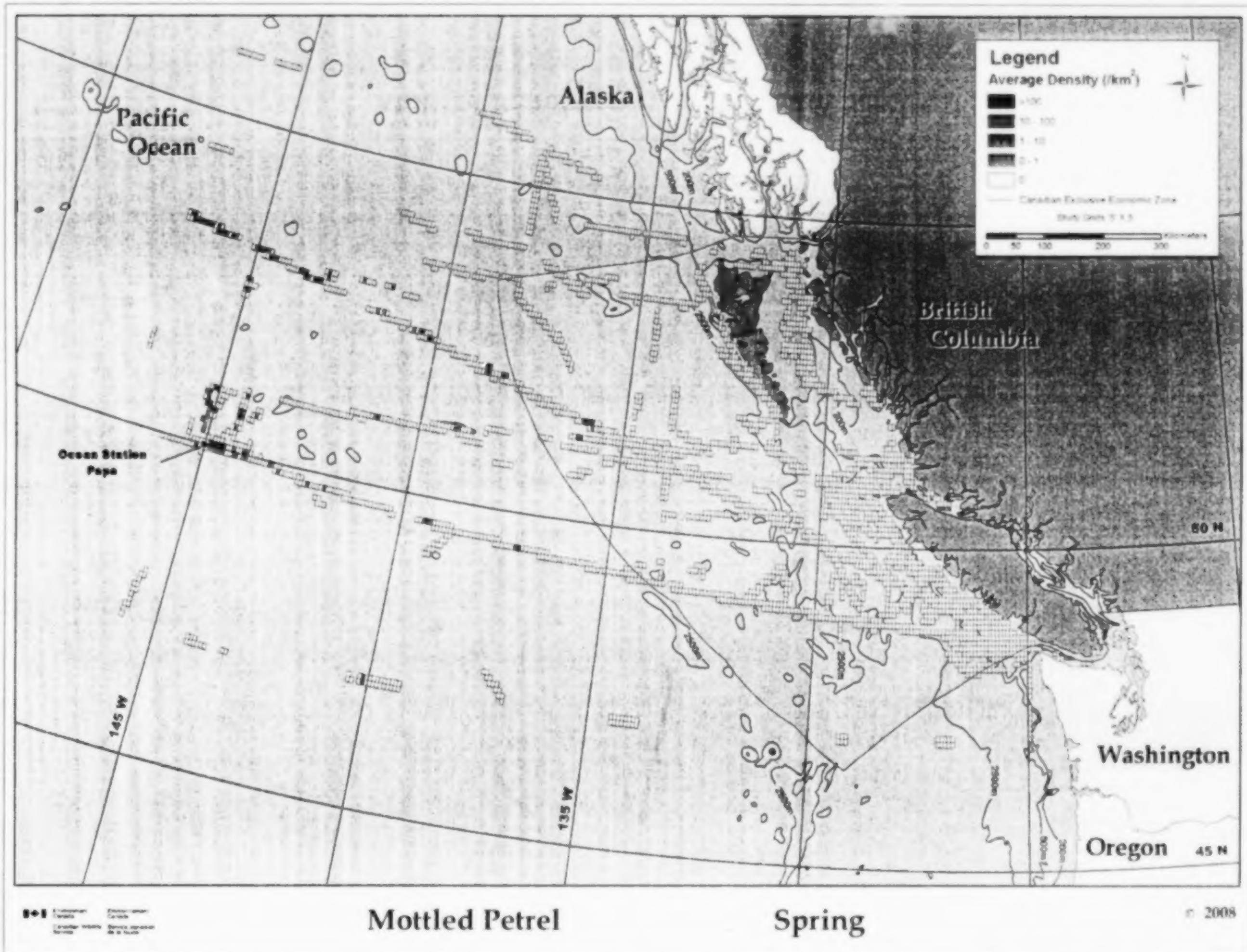


Figure 15A. Seasonal average grid cell densities of Mottled Petrels.

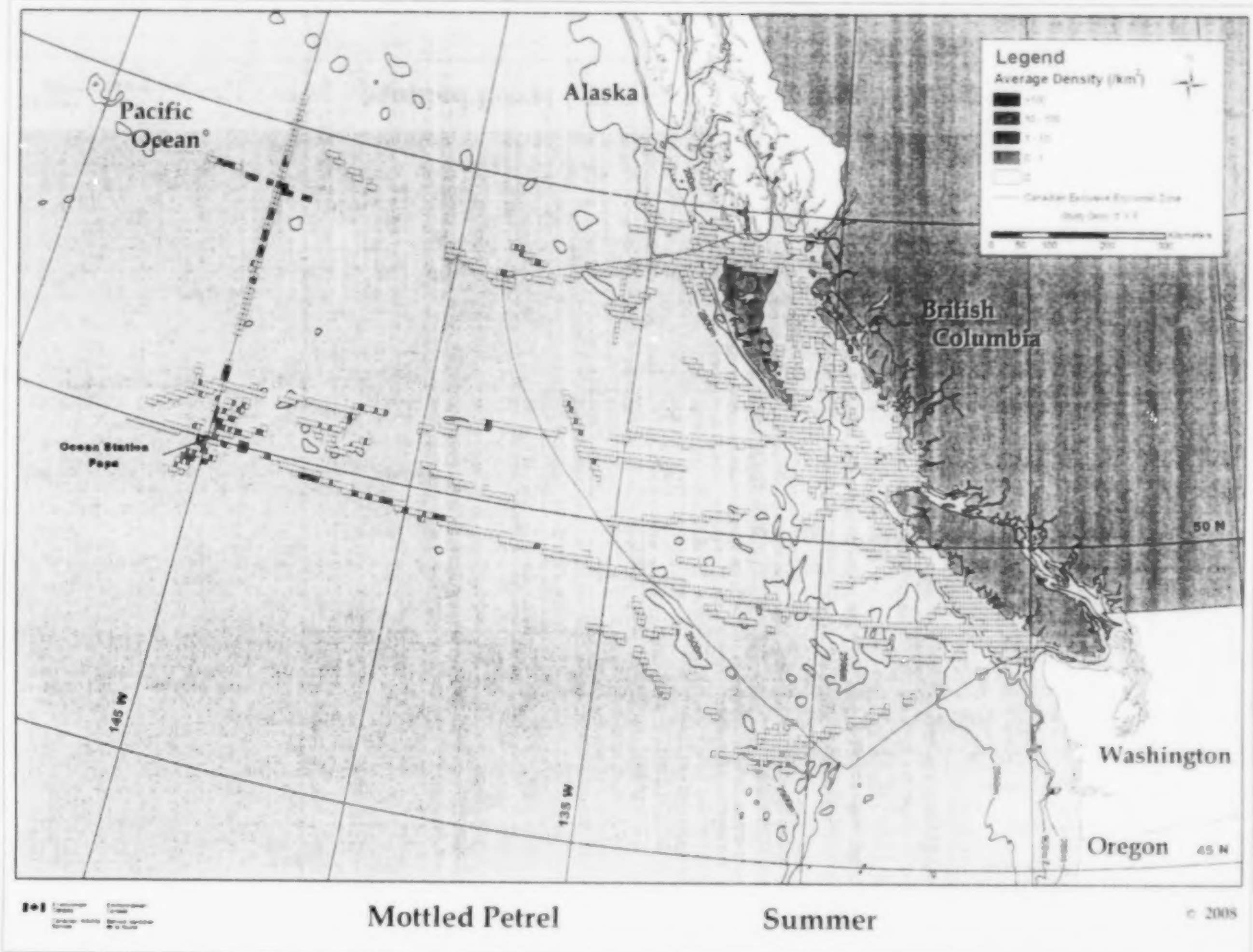


Figure 15B. Seasonal average grid cell densities of Mottled Petrels.

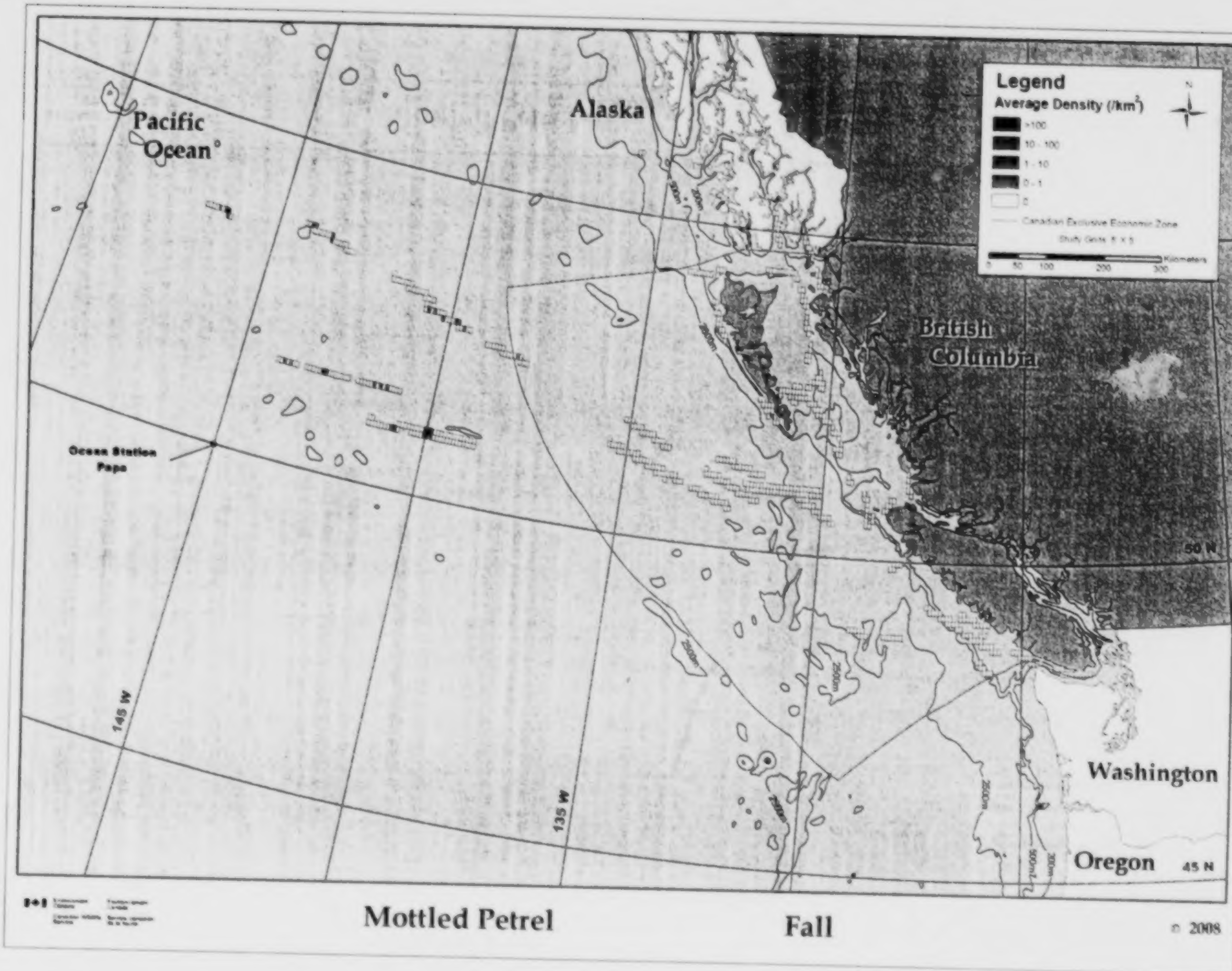


Figure 15C. Seasonal average grid cell densities of Mottled Petrels.

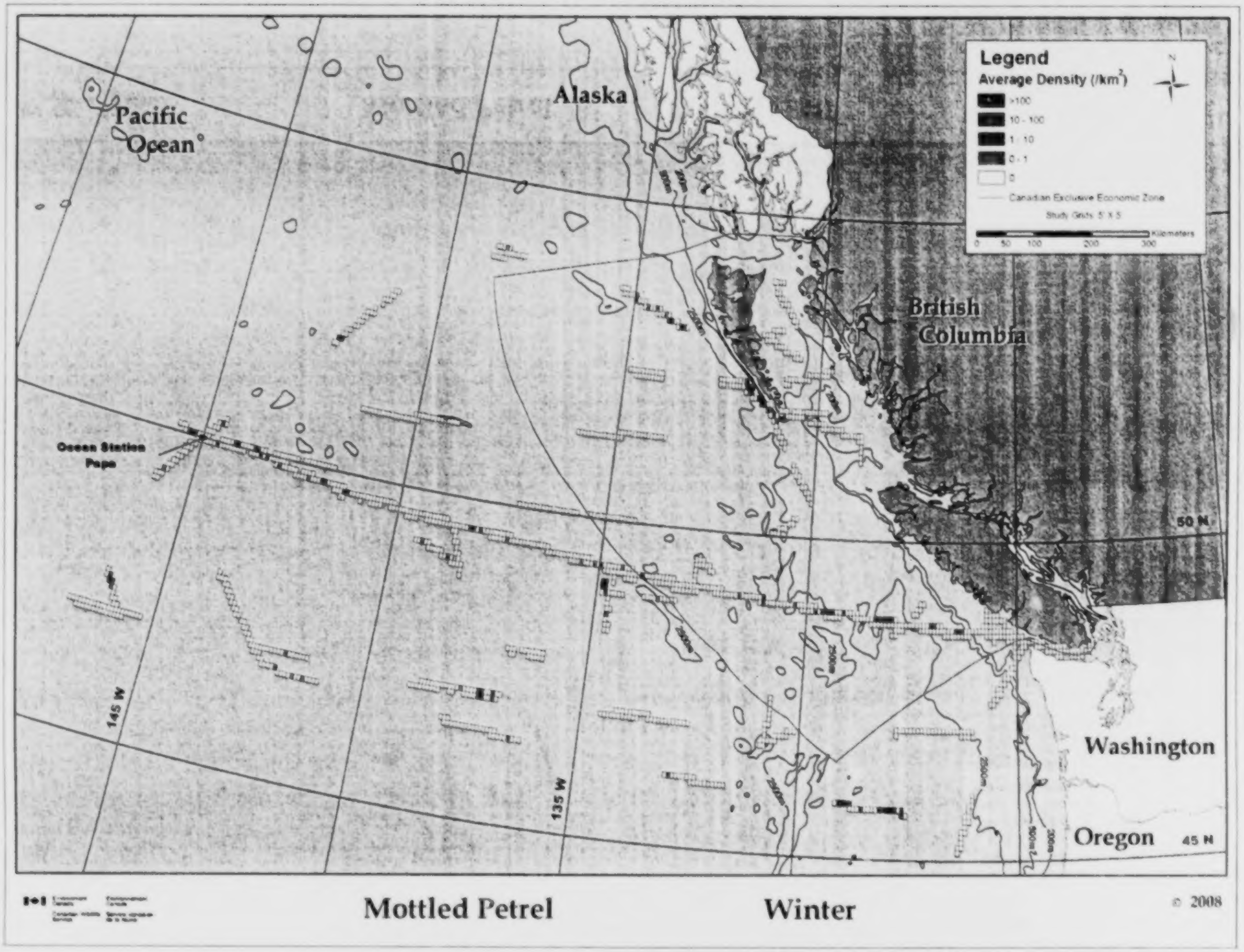


Figure 15D. Seasonal average grid cell densities of Mottled Petrels.

3.1.3.1 Mottled Petrel *Pterodroma inexpectata*

3.1.3.1.1 Population and Conservation Status

The global abundance of Mottled Petrels is estimated between 100,000 and one million individuals. However, due to a restricted breeding range and introduced predators at breeding colonies; it is ranked as *Near Threatened* by the IUCN (BirdLife International 2008) and NatureServe (2008) list the Mottled Petrel as globally *Vulnerable*.

3.1.3.1.2 Breeding Distribution and Chronology

Mottled Petrels are endemic to New Zealand, breeding on islands off Fjordland, the Solander Islands, islands in Foveaux Strait, islands near Stewart Island (Titi Islands, Codfish Island, Big South Cape Islands, and islets in Port Pegasus) and the Snares Islands Harrison 1983, Marchant and Higgins 1990). Breeding begins in October with birds departing their colonies in late April to early June (Harrison 1983, Marchant and Higgins 1990).

3.1.3.1.3 Oceanic Distribution and Diet

The species ranges at sea from southern waters between New Zealand and South America,.north to the Aleutian Islands, including the GOA and the west coast of N America (Harrison 1983, BirdLife International 2008). Bartle *et al.* (1993) described the distribution of Mottled Petrels as widespread and abundant in the northwest and central Pacific, between June and October. Ainley and Manolis (1979) considered the Mottled Petrel to be a common May – October resident in the northern and eastern N Pacific, found primarily in association with Transitional, Central and Western Sub-Arctic and Alaskan Stream waters (Dodimead *et al.* 1963). Ainley and Manolis (1979) also stated that the species normal migratory route took them "*…near the Americas only in Alaska, thus the scarcity of North American records from British Columbia is not too surprising.*"

Wahl *et al.* 2005 reported that Mottled Petrels have occurred in WA waters from mid-February through mid-Mar, mid-April through mid-May, early July and mid-November to early December.

Between 1996 and 2006, lower densities of Mottled Petrels were encountered in the northeastern N Pacific and the GOA than during the period 1975 through 1989 (Morgan *et al.* unpubl. 2007). Controlling for survey effort, they found that most birds seen during those early years were encountered during the non-breeding season (i.e., between May and September). In marked

contrast, the more recent data indicated that on an annual basis, the highest densities now occur during the breeding season (October through April).

There is little information on the diet of Mottled Petrels; what has been summarized suggests that it includes crustaceans, squid and fish (e.g., myctophids) with lesser amounts of tunicates (Brooke 2004). Mottled Petrels capture their prey by surface-seizing or surface-plunging (Harper *et al.* 1985).

3.1.3.1.4 Spatial Distribution and *Average Grid Cell Density* in Study Area

Within the study area, Mottled Petrels were encountered from early February through mid-October, generally well offshore. From spring through fall, all Mottled Petrels were observed west of 135° W, and few were found within the Canadian EEZ.

Spring Mottled Petrel grid cell densities (primarily during the first half of June) averaged <2.9 birds/km^2. The largest flock encountered in this season consisted of six birds (on 3 June 2002) seen approximately 900 km west of Graham Island.

From mid-June through summer and fall, most Mottled Petrels were seen well offshore, especially near OSP, as well as between 730 and 860 km west of the QCI. The largest summer grouping of Mottled Petrels was a loose flock of 23 birds (11.3 birds/km^2), encountered west of 135° W.

There were only 30 encounters of Mottled Petrels between the second half of September and the middle of October; all observations were of either single individuals or pairs. With the exception of one bird at the edge of the EEZ, all fall observations were between 445 and 815 km from land.

In contrast with the other seasons, Mottled Petrels were relatively common during winter (early February through early Mar) and they were seen much closer to the coast. As well as occurring well offshore during winter (to OSP and beyond), birds were encountered <15 km west of Moresby Island, and within 100 km of the west coast of Graham Island.

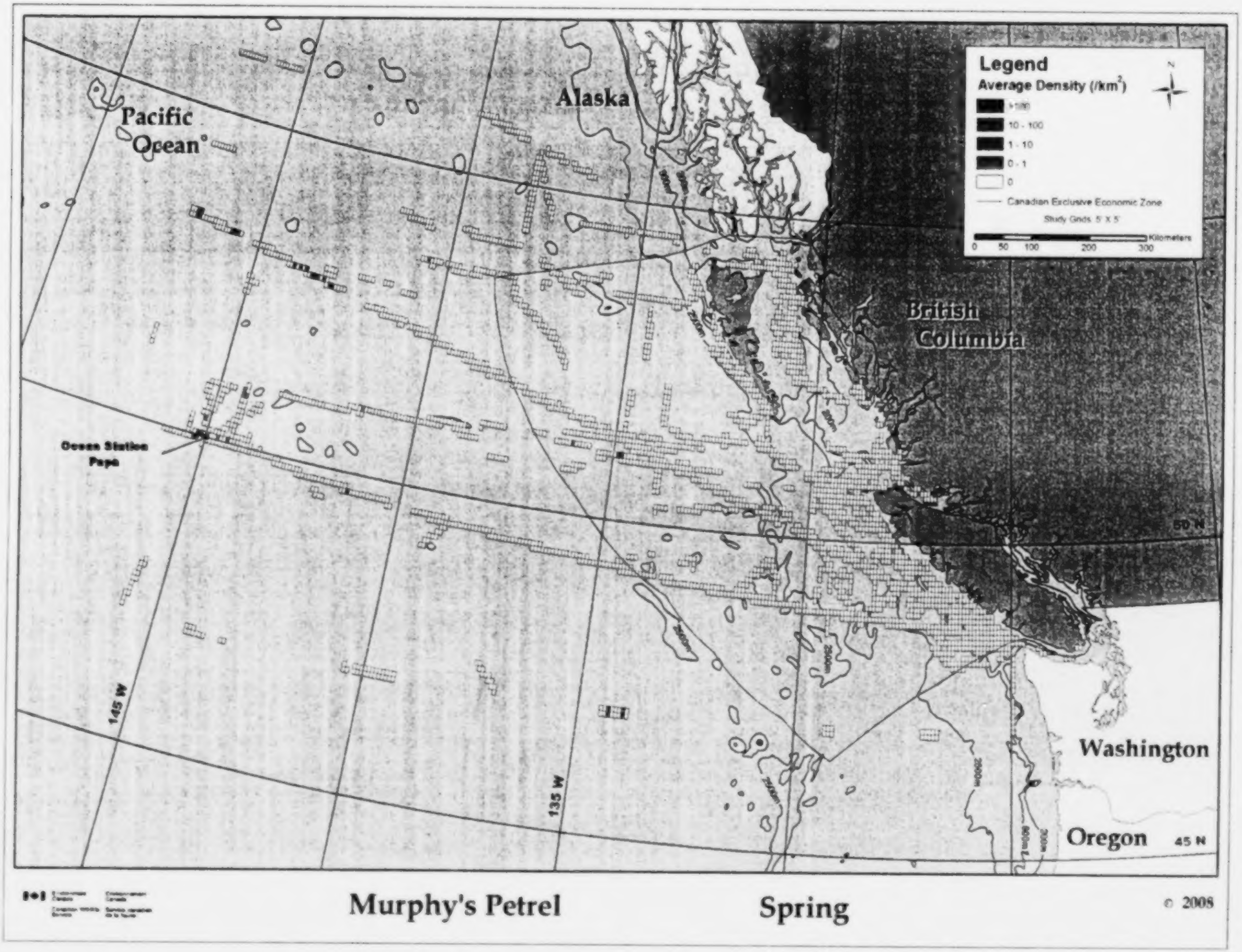


Figure 16A. Seasonal average grid cell densities of Murphy's Petrels.

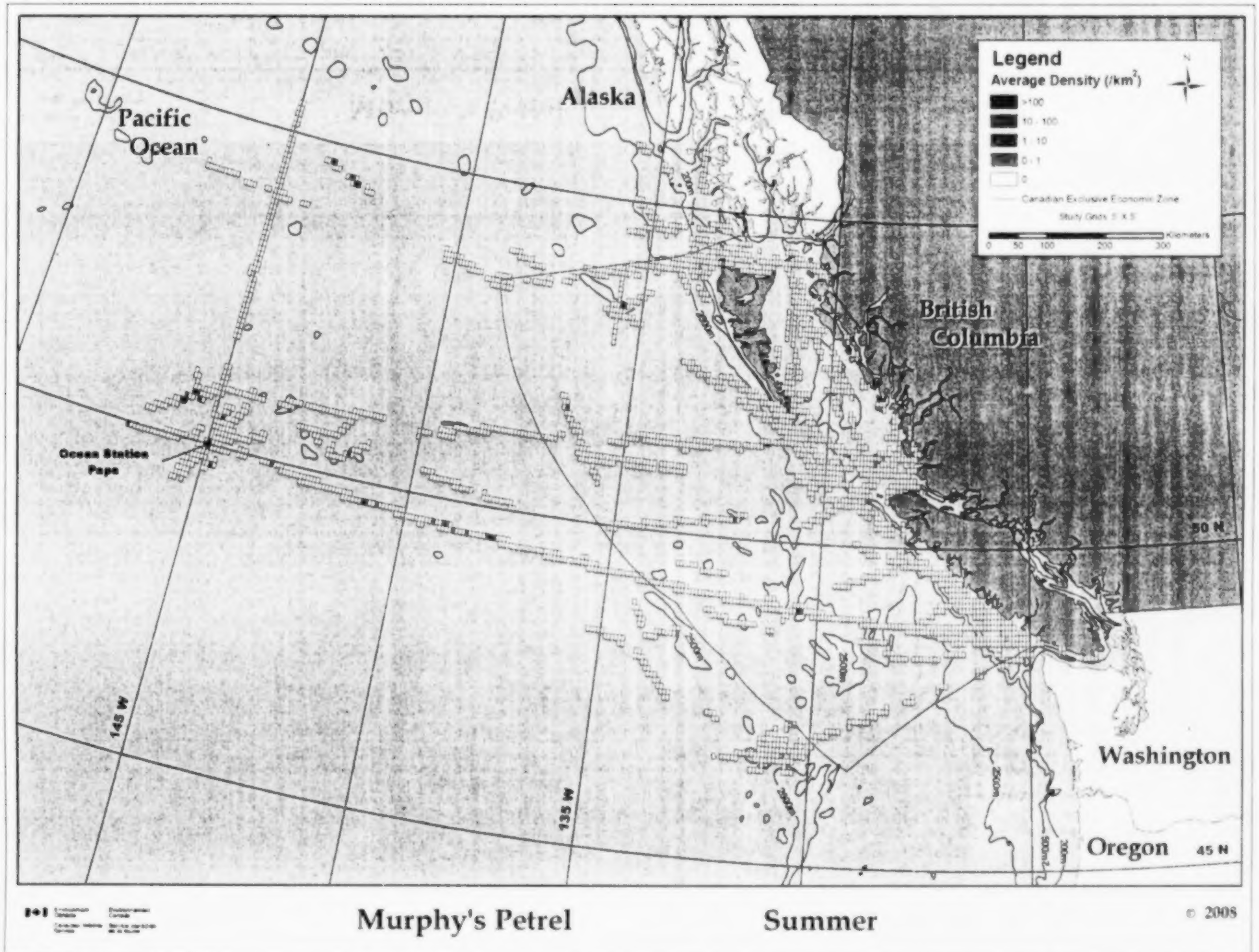


Figure 16B. Seasonal average grid cell densities of Murphy's Petrels.B

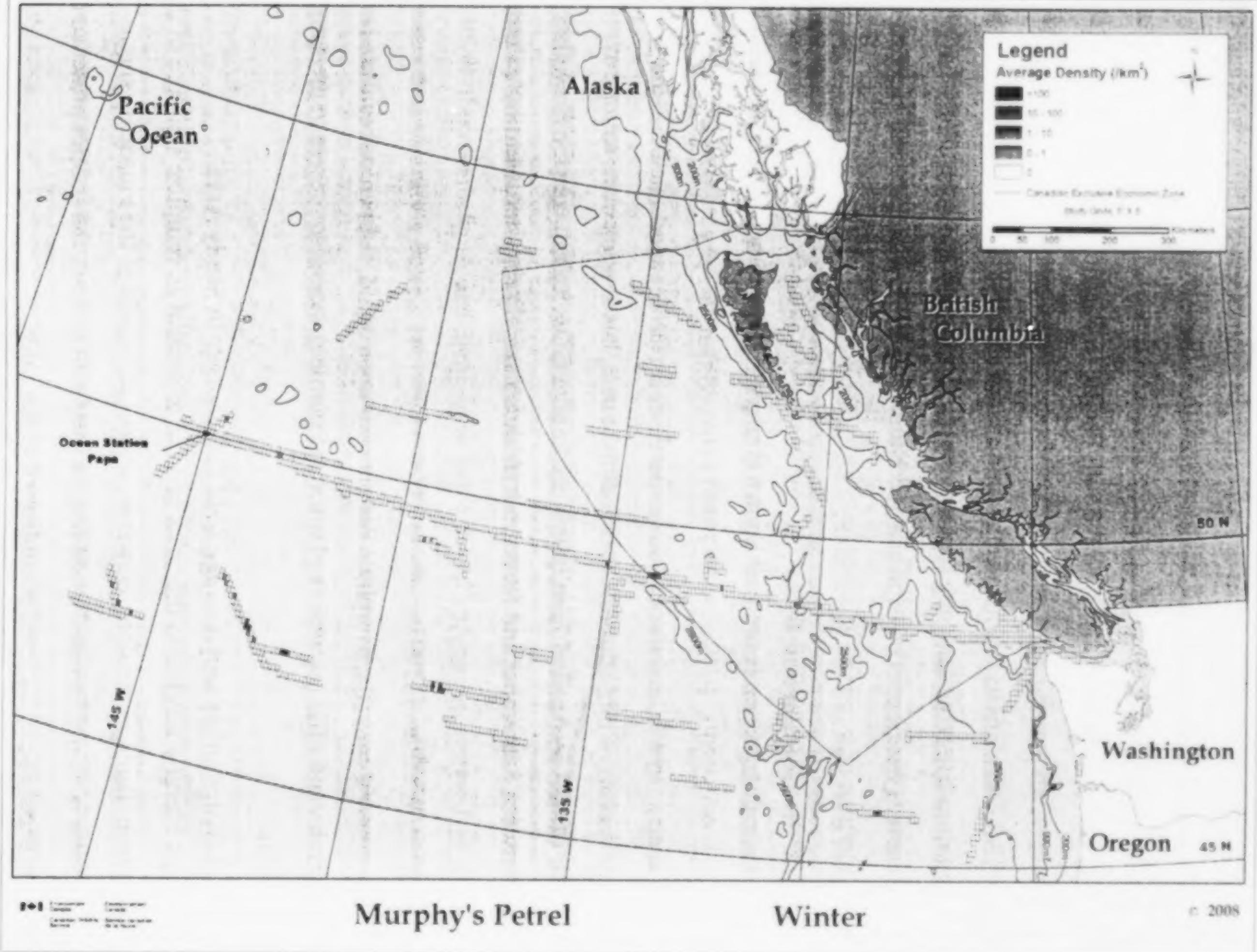


Figure 16C. Seasonal average grid cell densities of Murphy's Petrels.

3.1.3.2 Murphy's Petrel *Pterodroma ultima*

3.1.3.2.1 Population and Conservation Status

The global abundance of Murphy's Petrel is estimated between 100,000 and one million birds. The species is listed as globally *Imperilled to Vulnerable* by NatureServe (2008), whereas, they are ranked as *Near Threatened* by the IUCN (BirdLife International 2008).

3.1.3.2.2 Breeding Distribution and Chronology

Murphy's Petrels nest on islands of the central South Pacific (S Pacific) including the Lord Howe Island group, the Tuamotu Archipelago, the Pitcairn Group, and the Austral Islands (Harrison 1983). Adults return to Lord Howe Island in late February or early March; females lay a single egg in mid- to late May; hatching typically starts in mid-July and most chicks have fledged by November (Whitley 1934, McKean and Hindwood 1965, Marchant and Higgins 1990, Brooke 1995).

3.1.3.2.3 Oceanic Distribution and Diet

The species' pelagic distribution is not well known (Harrison 1983). Based on observations from the 1960's through the 1980's, Bailey *et al.* (1989) believed that Murphy's Petrels were present in N American waters from March through June. Bartle *et al.* (1993) speculated that there was an anticlockwise movement of birds during the breeding season, based upon observations of Murphy's Petrels off CA in April to June/July, the southern GOA in July, and the Hawaiian Islands region between September and November. Although rarely reported, Murphy's Petrels have occurred in WA waters in late April, early May, mid-June, late August and up to the third week of September (Wahl *et al.* 2005).

Based on chick stomach contents, Murphy's Petrels prey upon squid, fish, crustaceans and insects; coelenterates and offal (as well as plastics and pumice) were also present in the samples (Imber *et al.* 1995).

3.1.3.2.4 Spatial Distribution and *Average Grid Cell Density* in Study Area

We have included Murphy's Petrel in this atlas in order to present as complete a picture of the west coast marine avifauna as possible. However, almost all sightings were made by single observers, and there is no documented proof (e.g., a specimen record), the species presence in Canadian waters should be considered unconfirmed at this point.

Based upon the at-sea observations, it appears that Murphy's Petrels were actually relatively common to the study area, having been encountered in every season but fall. Most birds were

observed far offshore, with only a few sightings within Canada's EEZ. The Murphy's Petrels seen within the EEZ were generally found near seamounts. Most sightings were of 1-2 individuals.

There were 37 spring observations of Murphy's Petrel, with *average grid cell densities* ≤1.4 birds/km^2. All spring sightings took place during the first half of June; the largest group observed was four birds (seen on 6 June 2004). This species was encountered well offshore, out to OSP and beyond.

Murphy's Petrels were encountered 36 times during summer; birds were seen both well offshore and within the EEZ. The highest *average grid cell densities* were north of OSP. Two Murphy's Petrels were found close to Bowie Seamount, one bird was encountered relatively close to Dellwood Seamount, and one bird was found over Explorer Seamount. Bailey *et al.* (1989) noted that the most northerly record of Murphy's Petrel in the N Pacific was seen during the third week of July in the southern GOA (54.45° N, 144.87° W). The location (and timing) closely matches the most northern observation of Murphy's Petrels from this study; we observed a single bird on 20 June in the southern GOA (54.68° N, 143.78°W).

In winter, all 35 sightings of Murphy's Petrels occurred south of 52° N latitude. They were scattered at low *average grid cell densities* (most <0.6 birds/km^2) throughout the southern sub-regions, within and outside the Canadian EEZ. Murphy's Petrels were found in close association with Explorer Seamount during winter as well.

Based on the results from this study as well as the records presented by Wahl *et al.* (2005), it appears that Murphy's Petrels are present in the northeastern N Pacific longer than was originally suggested by Bailey *et al.* (1989) and Bartle *et al.* (1993); i.e., from at least early February through the end of September.

3.1.4 Shearwaters

Short-tailed Shearwater (*Puffinus tenuirostris*).
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Most shearwaters are S Hemisphere breeders, undertaking trans-equatorial migrations to the N Hemisphere during the austral winter. The abundance of shearwaters is generally higher in BC during May through November. Many species of shearwaters are highly gregarious at sea, forming dense feeding flocks, where they feed at the water's surface, or by underwater pursuit (Harrison 1983). Five species of shearwaters (Buller's, Flesh-footed, Pink-footed, Sooty and Short-tailed) were regularly encountered within the study area. Two other rare shearwaters (Manx and Black-vented) were observed; details on these species are presented in section 3.4.

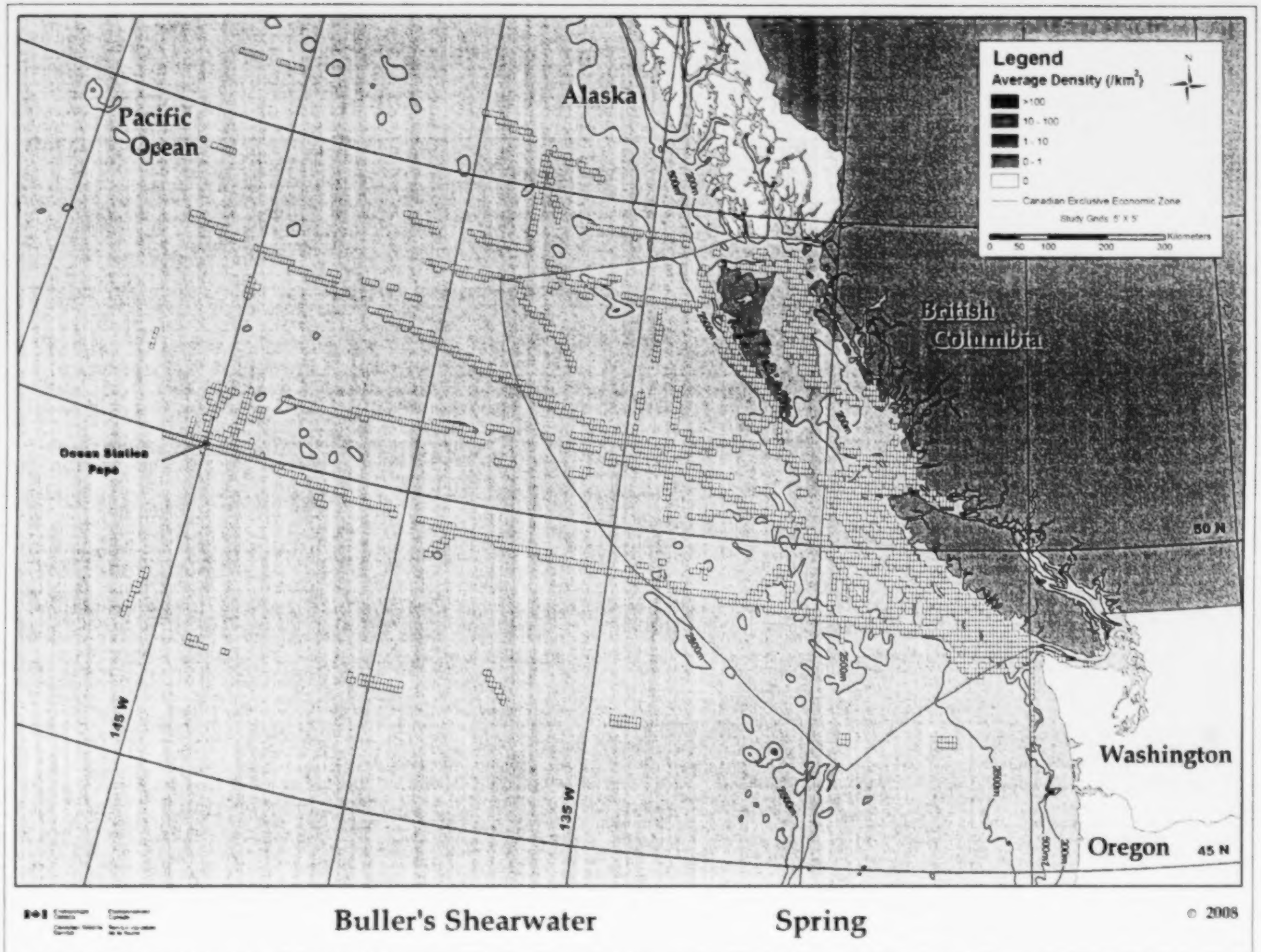

Figure 17A. Seasonal average grid cell densities of Buller's Shearwaters.

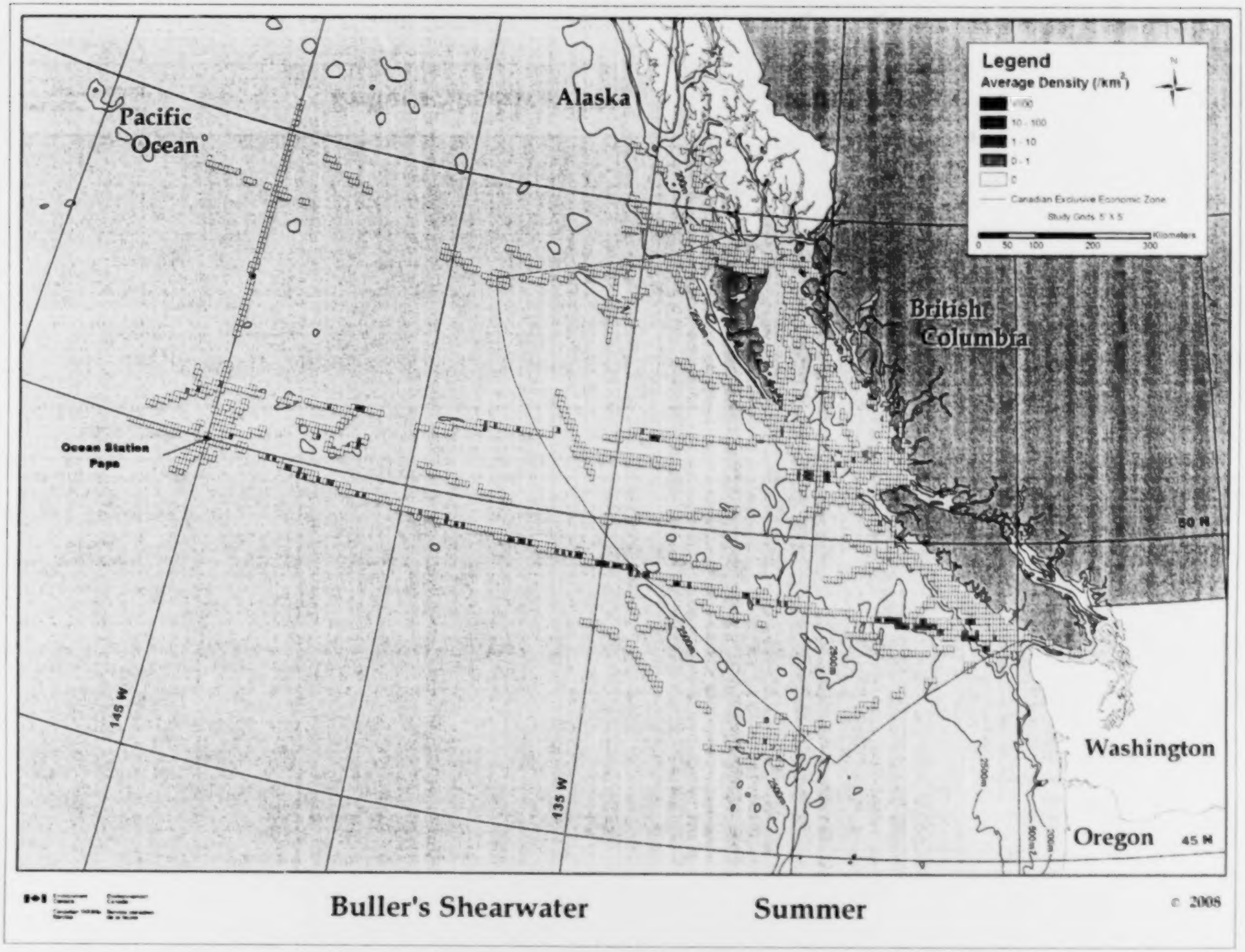

Figure 17B. Seasonal average grid cell densities of Buller's Shearwaters.

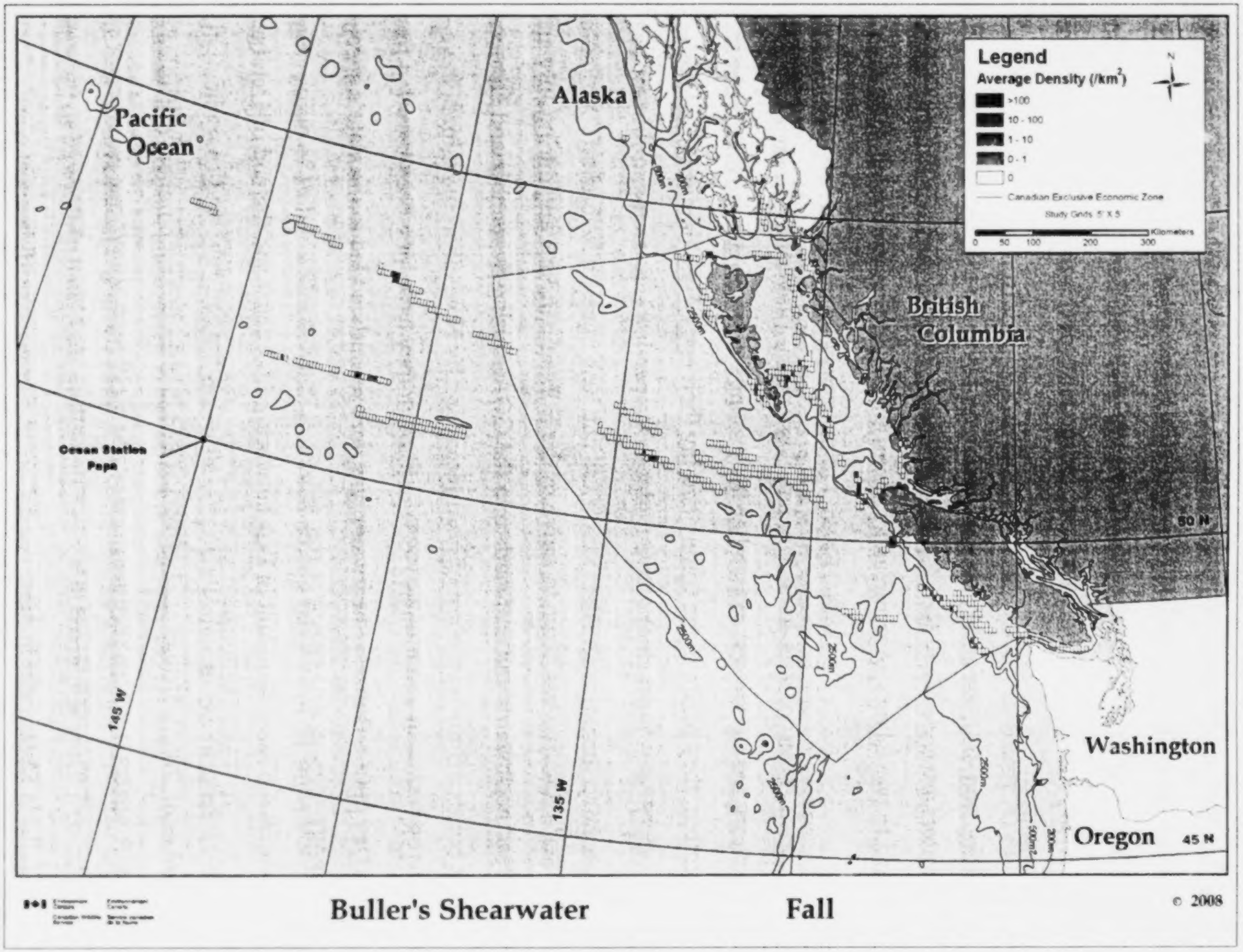

Figure 17C. Seasonal average grid cell densities of Buller's Shearwaters.

3.1.4.1 Buller's Shearwater *Puffinus bulleri*

3.1.4.1.1 Population and Conservation Status

The global population of Buller's Shearwater is estimated at 2,500,000 individuals. However, because of their restricted breeding distribution (i.e., they nest only on the Poor Knight Islands, New Zealand), they are ranked by the IUCN as globally *Vulnerable* (BirdLife International 2008). Buller's Shearwaters are ranked as *Not Currently at Risk* in Canada by Milko *et al.* (2003); however, they are on BC's *Blue List* (i.e., indigenous species and subspecies of special concern in the province).

3.1.4.1.2 Breeding Distribution and Chronology

Buller's Shearwaters are endemic to New Zealand, breeding only on the Poor Knights Islands; they are restricted to two islands, Aorangi and Tawhiti Rahi, and five other islets (Marchant and Higgins 1990).

Breeding birds arrive at the colonies in mid- to late September. They refurbish their burrows and then leave the colony around the end of October for a month-long pre-laying "honeymoon". Near the end of November, they return to the colony and lay their eggs. Hatching occurs in mid-January; and by early May, most chicks have fledged (Harper 1983, Everett and Pitman 1993).

3.1.4.1.3 Oceanic Distribution and Diet

Numbers of Buller's Shearwaters begin to arrive in the N Pacific in June and during July and August they spread northwards and eastwards into the GOA. During September and October the number of birds builds off the west coast of N America, but by November, most birds have departed (Wahl 1985, Everett and Pitman 1993). Although they have long been reported from the northern GOA (Day 2006), Buller's Shearwater was very recently added to the state's species list (Gibson *et al.* 2008).

Buller's Shearwaters are most abundant in WA between mid-August and the end of October; however, they have also been observed (rarely) in January, June and July, and sporadically in November (Wahl *et al.* 2005). Briggs *et al.* (1987) stated that the largest numbers of Buller's Shearwaters in CA waters "*...were seen seaward of the shelfbreak, usually on the warmer sides of temperature fronts*". They also noted that when upwelling slackened, there was an increase in the number of Buller's Shearwater in more coastal areas. For waters off the west coast of Vancouver Island, Vermeer *et al.* (1992) found a significant positive relationship between the

abundance of Buller's Shearwaters and water depth, distance from land and sea surface temperature (SST).

Buller's Shearwaters feed upon fish (e.g., Pacific saury, Gould *et al.* 1998), squid, crustaceans, euphausiids (e.g., *Nyctiphanes australis*, Harper 1983) and offal (Marchant and Higgins 1990). Food is captured by a variety of methods including dipping to the surface or seizing prey while swimming (both without immersion), or by pursuit-plunges from above the water that take the bird completely underwater (Brooke 2004).

3.1.4.1.4 Spatial Distribution and *Average Grid Cell Density* in Study Area

Buller's Shearwaters were observed on pelagic surveys from late May through late October; peak numbers were between late summer and early fall, along the shelfbreak. Sightings spanned most of the latitudinal extent of the study area; from just north of Langara Island to approximately 46° N (about 500 km west of Grays Harbor).

This shearwater species was rarely encountered during spring; one Buller's Shearwater was seen on 28 May 2003 over the shelfbreak southwest of Barkley Sound, and two were observed west of Cape St. James on 12 June 2003.

Buller's Shearwaters were most numerous during summer, especially in August and early September. The highest *average grid cell densities* (10.0-15.0 birds/km^2) occurred over the edge of La Perouse Bank. Sightings of birds occurred all along Line P, generally at low densities (<1.0 birds/km^2), out to OSP. The largest summer flock, estimated at 100 individuals was seen on 27 August 2001, approximately 75 km southwest of Barkley Sound.

Sightings of Buller's Shearwater (as well as survey effort) decreased after mid-September; most birds were found along the shelfbreak, from southwest of Barkley Sound to Dixon Entrance. The largest group of Buller's Shearwaters observed during fall was of 51 birds, seen on 17 September 2000, roughly 230 km southwest of Moresby Island.

Buller's Shearwaters are considered to be a very rare visitor to BC in summer, fairly common to common fall migrant and locally very common. The species has been reported in BC between 1 July and 8 November (Campbell *et al.* 1990a). More than a month later than the latest record in Campbell *et al.* (1990a), a Buller's Shearwater was seen and well described, by two individuals on 19 December 2007 (G.L. Monty, pers. comm.) approximately 3 km south of Victoria (estimated position 48.39° N, 123.39° W)

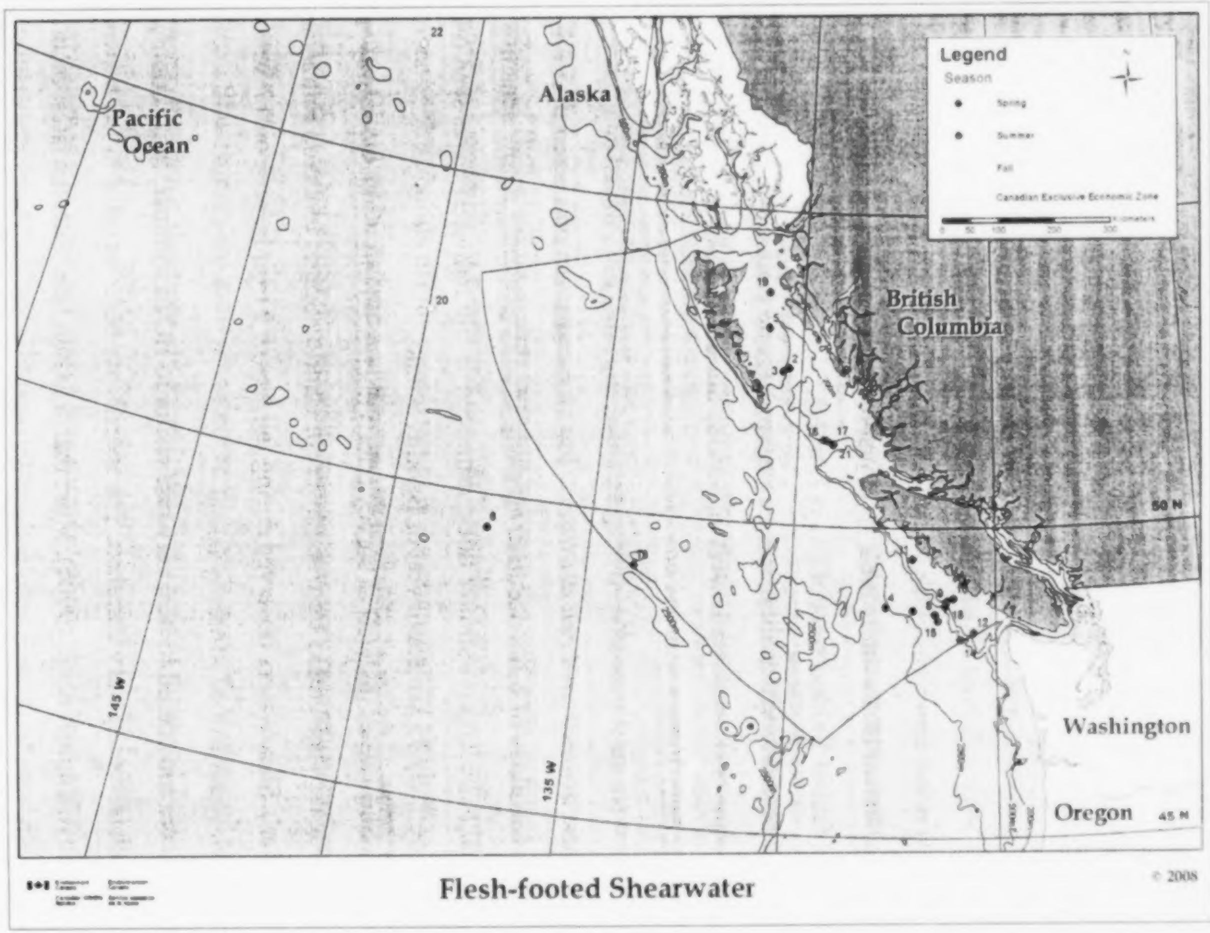

Figure 18. Locations where Flesh-footed Shearwaters have been observed.

See Appendix 1 for details.

3.1.4.2 Flesh-footed Shearwater *Puffinus carneipes*

3.1.4.2.1 Population and Conservation Status

The global breeding population of Flesh-footed Shearwaters is estimated to exceed 300,000 individuals (Fishpool and Evans 2001). Global population trends have not been quantified, but the species is not believed to approach the thresholds for the population decline criterion of the IUCN Red List (i.e., declining >30% in ten years or three generations, IUCN 2008); as a consequence they are listed globally as a species of *Least Concern* by the IUCN (BirdLife International 2008). Baker and Wise (2005) modeled the bycatch of Flesh-footed Shearwaters in eastern Australia's pelagic longline fishery for Tuna and Billfish, and concluded that the level of bycatch was "*….most likely unsustainable and threatens the survival of the Lord Howe Island population*". In consideration of the level of bycatch, as well as their restricted breeding distribution and breeding habitat degradation (Priddel *et al.* 2006), NatureServe (2008) list the Flesh-footed Shearwater as *Vulnerable* to *Apparently Secure*. On the other hand, Kushlan *et al.* (2002) and Milko *et al.* (2003) consider it to be a species of *Low Conservation Concern* in N America.

3.1.4.2.2 Breeding Distribution and Chronology

Flesh-footed Shearwaters breed on St. Paul Island (Indian Ocean), Lord Howe Island (eastern Australia), southwest mainland Australia, and North Island (New Zealand). Lord Howe Island supports a breeding population of between 20,000 and 40,000 pairs. The southwestern breeding population is estimated to be between 100,000 and 200,000 pairs, distributed throughout >30 colonies (Blakers *et al.* 1984, cited in Everett and Pitman 1993).

Breeders return to the Australian colonies about the third week of September, most eggs are laid within a two-week interval between late November and early December, most eggs hatch between the last week of January and early February, and by approximately the middle of May, most fledglings have left the colonies (Marchant and Higgins 1990, Powell 2004).

3.1.4.2.3 Oceanic Distribution and Diet

The at-sea distribution of the species is not well known. According to del Hoyo *et al.* (1992), during the non-breeding season Flesh-footed Shearwaters range north through the western N Pacific to the Aleutian Islands, with small numbers off the west coast of N America, north through the Indian Ocean and west to the southern tip of Africa. Everett and Pitman (1993) noted that although the trans-equatorial "migratory route is poorly known, some birds move along the

west coast of the Americas". Flesh-footed Shearwaters have been recorded in the N Pacific from BC to CA (Harrison 1983, Morgan *et al.* 1991). Although there are reported sightings of Flesh-footed Shearwaters in AK waters, the species is considered to be "unsubstantiated in Alaska" (Gibson *et al.* 2007).

Flesh-footed Shearwaters feed primarily upon small fish (e.g., Pacific saury), and to a lesser extent on squid and zooplankton (Gould *et al.* 1997b). Prey is taken either at the surface or by shallow diving to 4 m (Marchant and Higgins 1990).

3.1.4.2.4 Distribution in Study Area

A total of 22 Flesh-footed Shearwaters were observed in the study area. Most birds were encountered during spring (4 May – 10 June) and summer (19 June and 11 September); there were only three fall observations, all in the first week of October. All encounters were of single individuals. Many sightings occurred over the shelf, along the shelfbreak, and farther offshore. Most birds were found between the mouth of Juan de Fuca Strait and Nootka Island; however, they were also observed in Hecate Strait. To the south of the study area, Wahl *et al.* (2005) reported two birds from WA waters in February (2003) as "exceptional". They also indicate that Flesh-footed Shearwaters have been recorded in WA from late April to mid-December.

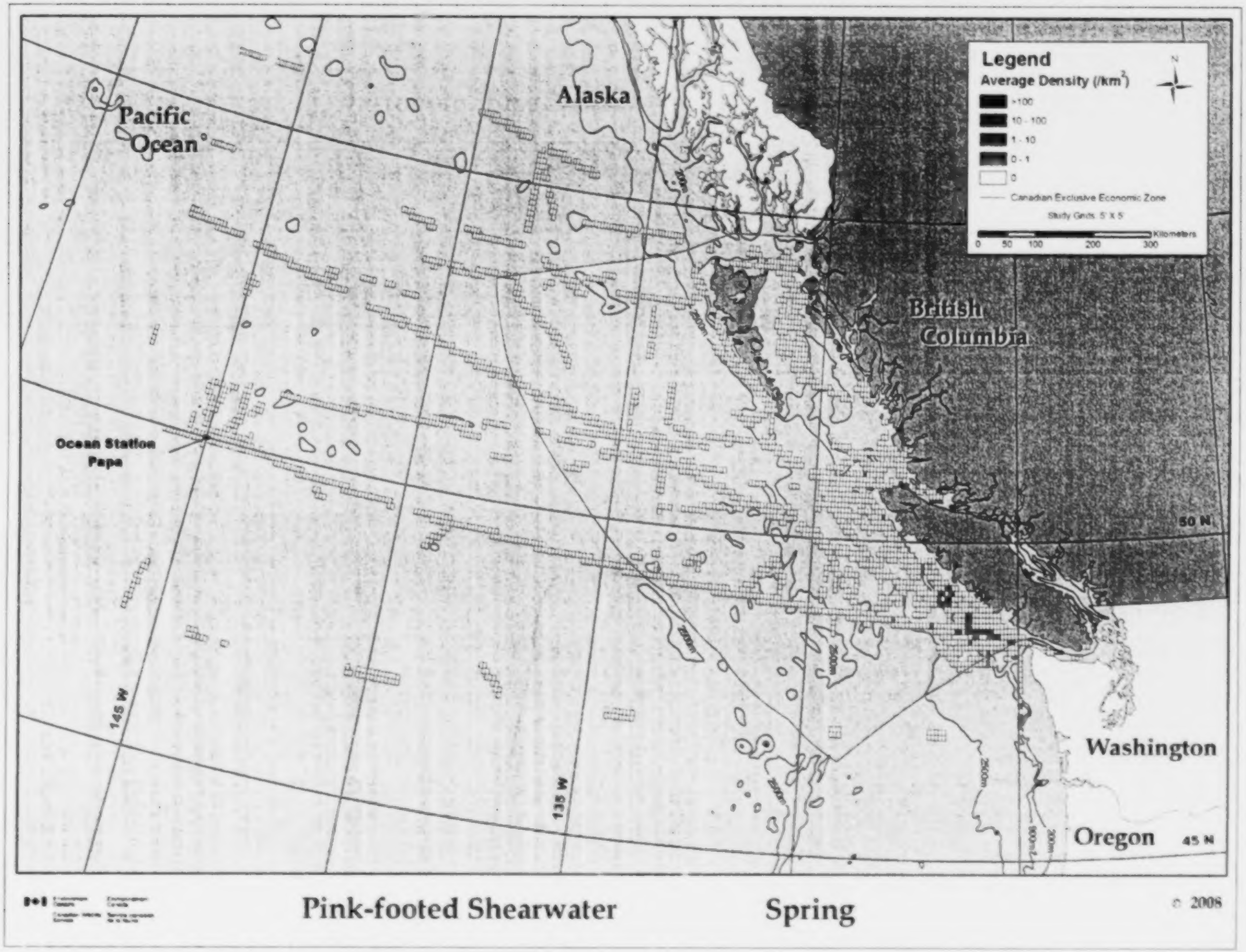

Figure 19A. Seasonal average grid cell densities of Pink-footed Shearwaters.

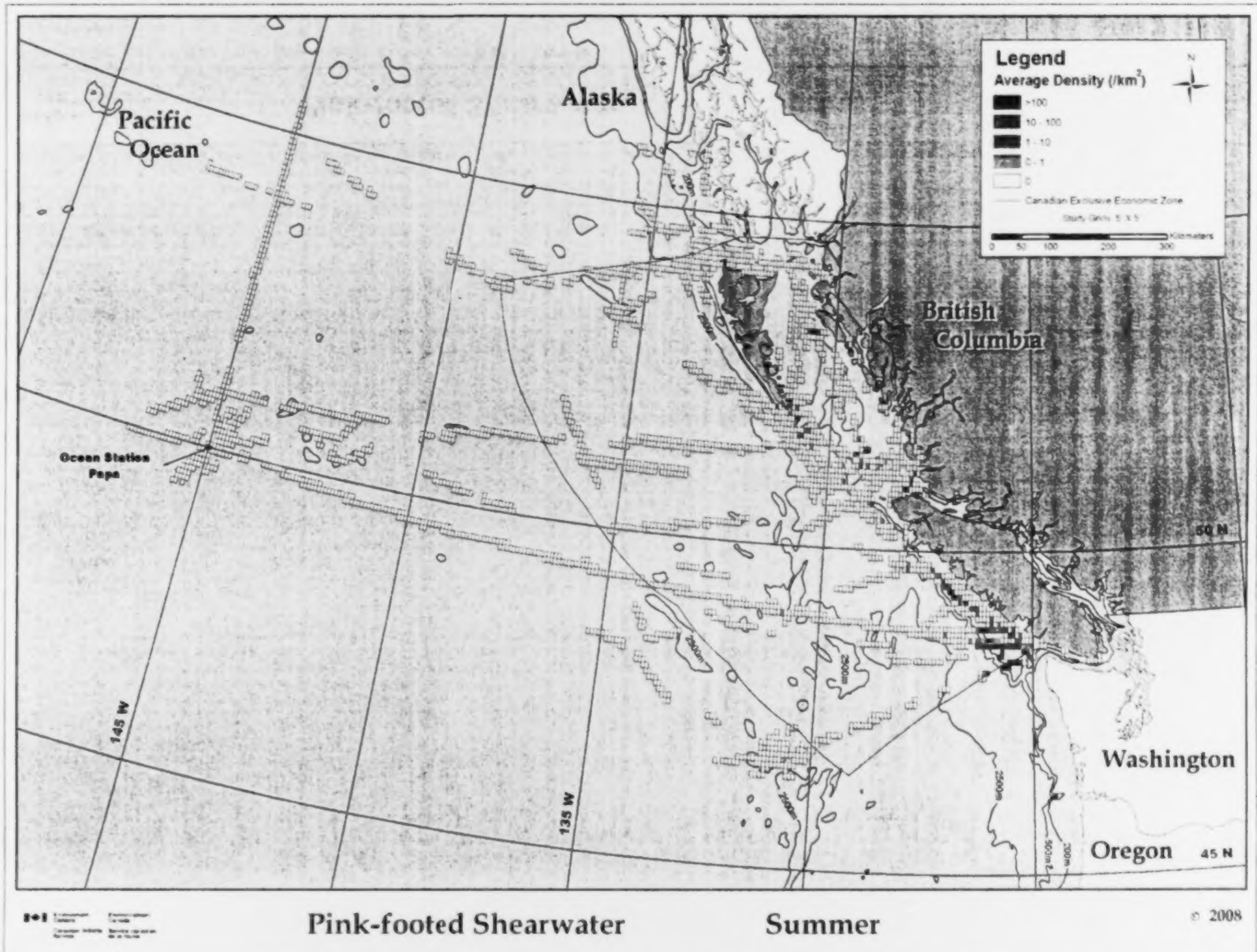

Figure 19B. Seasonal average grid cell densities of Pink-footed Shearwaters.

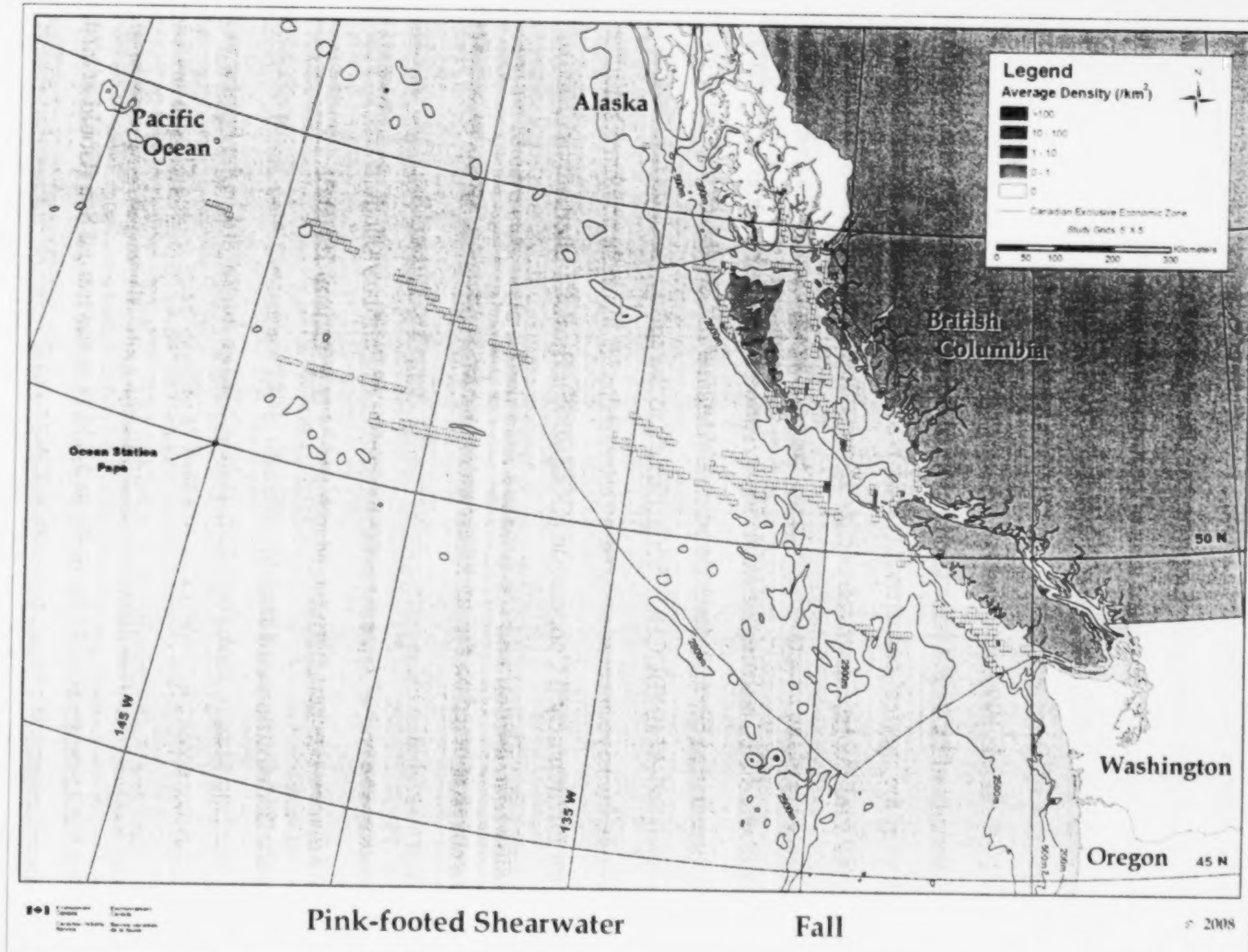

Figure 19C. Seasonal average grid cell densities of Pink-footed Shearwaters.

3.1.4.3 Pink-footed Shearwater *Puffinus creatopus*

3.1.4.3.1 Population and Conservation Status

Although reported that there may be between 34,000 and 60,000 nesting pairs of Pink-footed Shearwater globally (BirdLife International 2008), recent colony surveys suggest that there are fewer breeders (21,500 to 25,500 pairs, Environment Canada 2008). Due to the species' small breeding population size and its restricted area of occupancy (breeding sites), the Pink-footed Shearwater is considered to be globally *Critically Imperilled to Imperilled* by NatureServe 2008, *Vulnerable* by the IUCN (BirdLife International 2008) and *Vulnerable* in Chile (Rottmann and López-Callejas 1992, Glade 1993).

Based upon the density of birds that have been observed during at-sea surveys and the known geographic extent of the species' occurrence (COSEWIC 2004a), it was estimated that between 10,000 and 20,000 Pink-footed Shearwaters may occur within Canada's EEZ (Environment Canada 2008). Because of the estimated number of birds utilizing Canadian waters, the Pink-footed Shearwater was listed as being of *High Conservation Concern* by Milko *et al.* (2003). Nationally, the Pink-footed Shearwater is listed as *Threatened* in Canada (COSEWIC 2004a) and it is on the provincial *Red List* (BCCDC 2006). Threats to the species include habitat loss (at breeding locations), invasive species at breeding sites, fisheries bycatch, and harvesting for food (Commission for Environmental Cooperation [CEC] 2005), BirdLife International 2008).

3.1.4.3.2 Breeding Distribution and Chronology

Pink-footed Shearwaters breed on the Juan Fernandez and Mocha Islands off the coast of Chile. Breeders begin to assemble at the colonies in November, eggs are laid in December and January, hatching occurs from the end of January to the beginning of February (Hodum and Wainstein 2002, 2003) and dispersal occurs between March and May (Harrison 1983).

3.1.4.3.3 Oceanic Distribution and Diet

Following the breeding season, Pink-footed Shearwaters range northward in the Pacific to the GOA and the southern Bering Sea (Wahl *et al.* 1989). Although Pink-footed Shearwaters are relatively rare north of the southern tip of the QCI (Guzman and Myres 1983, Morgan *et al.* 1991), they have been encountered as far north as 58.34 N in the Bering Sea (Gould *et al.* 1982). Pink-footed Shearwaters tend to associate with the shelf and shelfbreak regions throughout their range (Guzman and Myres 1983, Guicking *et al.* 2001, Rintoul *et al.* unpubl. 2006)

Prey are captured in a variety of ways, including surface feeding, and surface and plunge-diving (Ainley and Sanger 1979, Ribic and Ainley 1988/1989). Although most foraging dives are shallow (about 2 m), some birds dive to depths exceeding 35 m (P. Hodum and S. Shaffer, unpubl. data 2008). The diet of Pink-footed Shearwaters consists of forage fish and small crustaceans (Ainley 1976, Guicking *et al.* 2001); apparently they eat more fish than other shearwaters (Stiles and Skutch 1989).

3.1.4.3.4 Spatial Distribution and *Average Grid Cell Density* in Study Area

Guzman and Myres (1983) considered the Pink-footed Shearwater to be the second-most numerous shearwater species in BC waters. As has been observed elsewhere, within the study area, Pink-footed Shearwaters were encountered primarily over the continental shelf and along the shelfbreak.

Pink-footed Shearwaters were encountered 49 times during spring, with the first birds seen in early May. Most sightings were of individuals, and the maximum number seen together during spring was five. The spring time *average grid cell densities* were $\leq$0.8 birds/km^2. Pink-footed Shearwaters were mostly found west of Vancouver Island, from approximately 30 km southwest of Estevan Point to about 60 km west of Cape Beale; a few birds were seen approximately 50 km west of the Olympic peninsula. There was only a single observation of a Pink-footed Shearwater in Queen Charlotte Sound during this season.

Pink-footed Shearwaters were at their peak abundance during summer. Most birds were found over the shelf or the shelfbreak off Vancouver Island from Swiftsure Bank north to Brooks Peninsula. Unlike spring, Pink-footed Shearwaters were regularly found in Queen Charlotte Sound, Hecate Strait and southwest of Moresby Island. The largest summer concentration of Pink-footed Shearwaters, estimated at 160 birds, was encountered about 40 km west of Amphitrite Point, on 1 September 2001; this coincidentally was near the location where a large flock (estimated at 140 birds) was seen on 24 August 1986 (Morgan *et al.* 1991).

All 33 Pink-footed Shearwater observations during fall were of single birds. With the exception of a bird seen approximately 35 km west of Barkley Sound, all fall sightings occurred north of 50° N.

There were no winter records of Pink-footed Shearwaters within the study area during winter. However, Wahl *et al.* (2005) note that the bird is seen in WA waters in all months of the year.

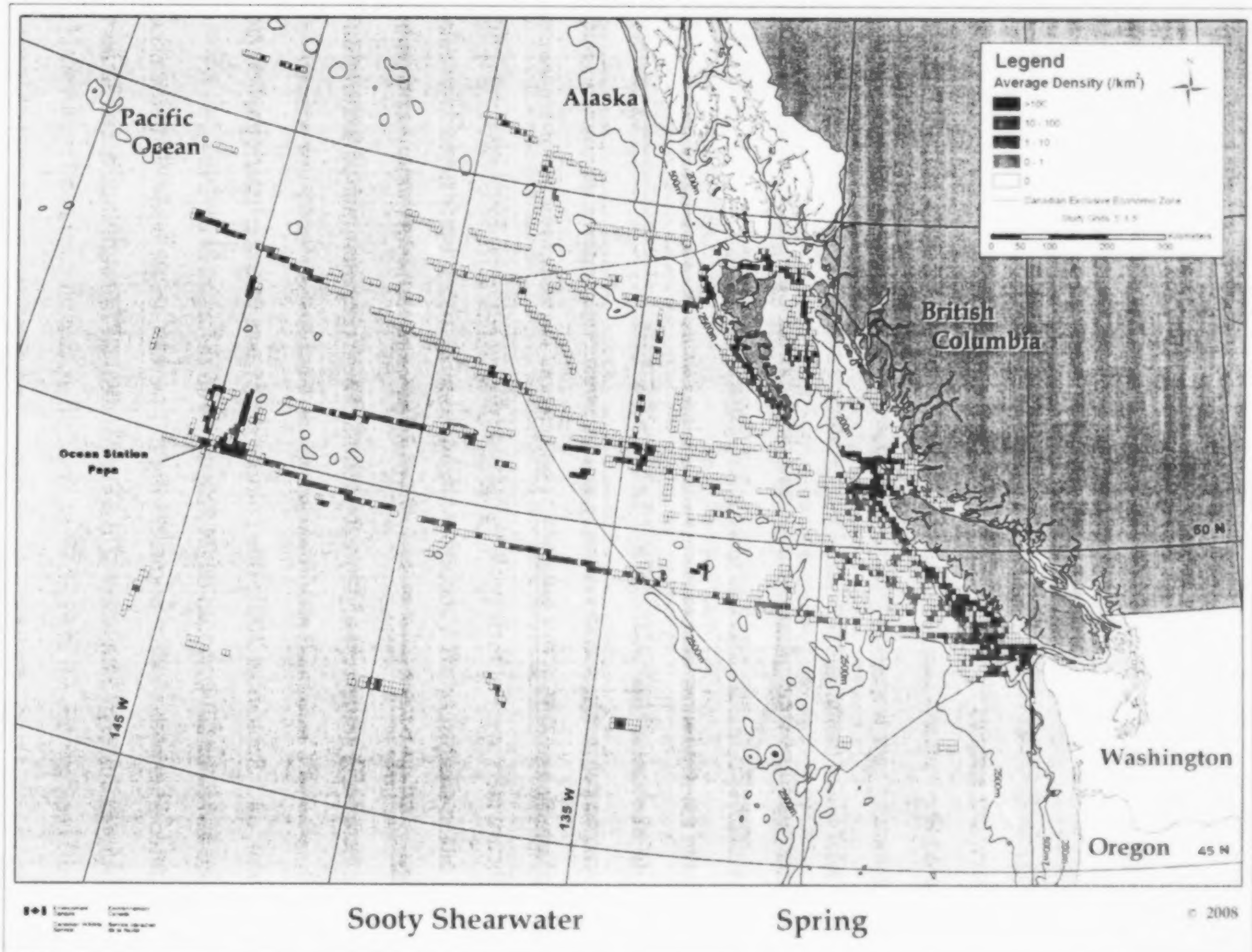

Figure 20A. Seasonal average grid cell densities of Sooty Shearwaters.

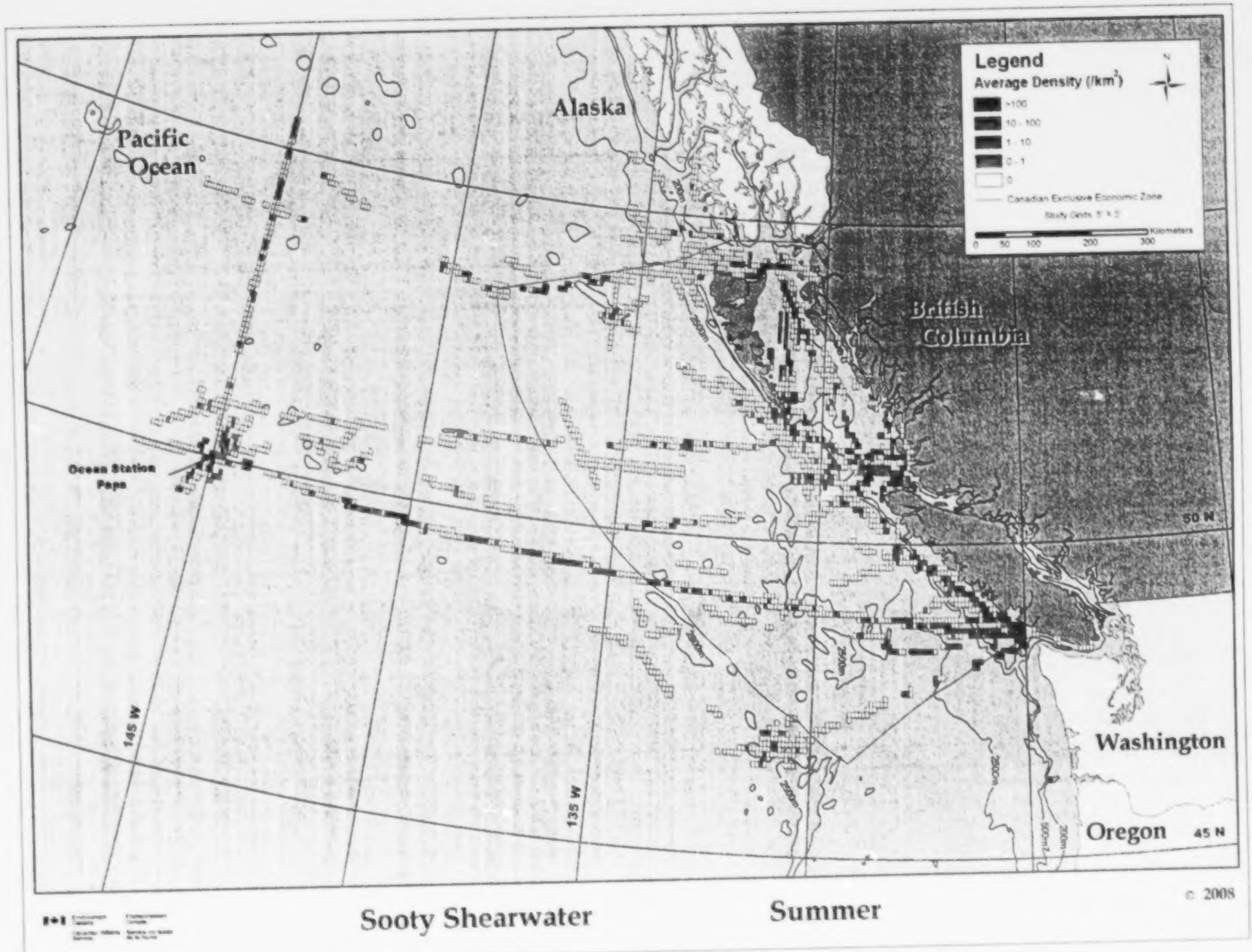

Figure 20B. Seasonal average grid cell densities of Sooty Shearwaters.

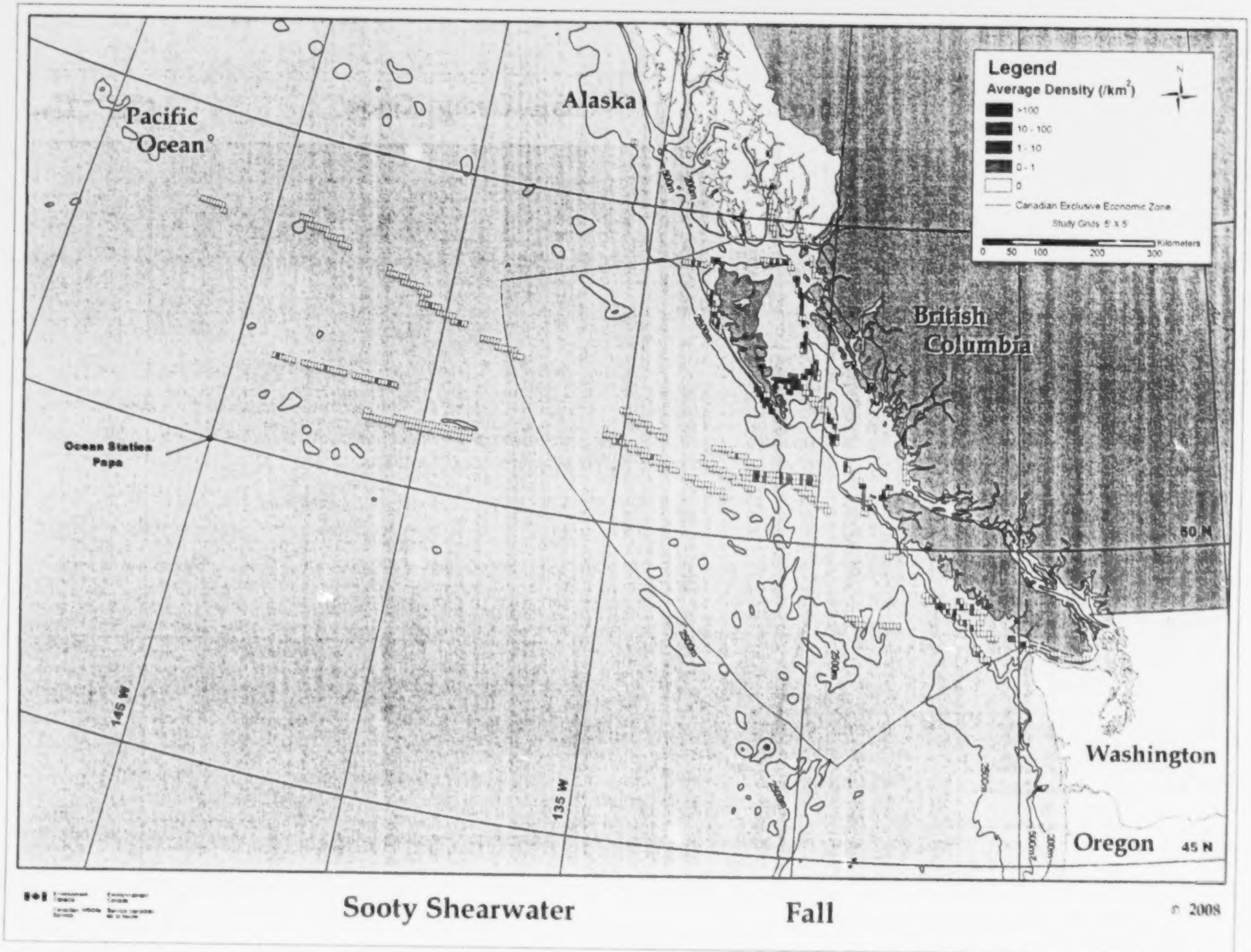

Figure 20C. Seasonal average grid cell densities of Sooty Shearwaters.

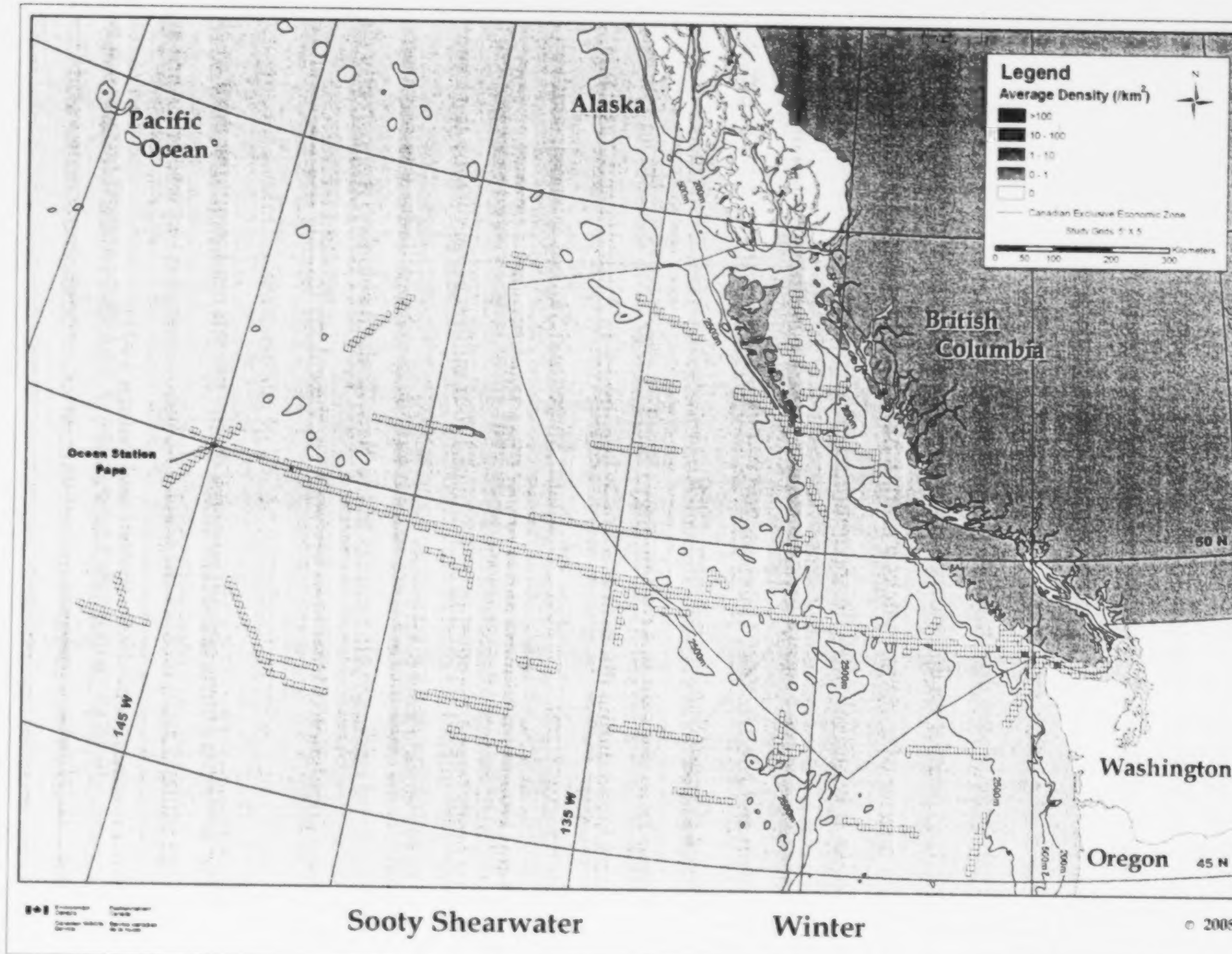

Figure 20D. Seasonal average grid cell densities of Sooty Shearwaters.

3.1.4.4 Sooty Shearwater *Puffinus griseus*

3.1.4.4.1 Population and Conservation Status

Sooty Shearwaters are one of the most abundant seabirds in the Pacific Ocean (Spear and Ainley 1999); their global population has been estimated at >20 million; however, persistent population declines have been recorded over the last 30-50 years (e.g., Jones 2000). Sooty Shearwaters are considered by the IUCN (BirdLife International 2008) to be globally *Near Threatened*; and of *Moderate Conservation Concern* in N America and Canada, respectively, by Kushlan *et al.* (2002) and Milko *et al.* (2003). Over the last few decades, Sooty Shearwater numbers in the California Current System have declined by 90% (Veit *et al.* 1997). It is unknown if that decrease is a result of population decline or distributional shifts (Spear and Ainley 1999). Approximately a quarter of a million chicks ('mutton birds') are harvested annually (del Hoyo *et al.* 1992); however, it is unlikely that the apparent decline could be accounted for solely by that activity. Another conservation concern for this species is their incidental catch in commercial fisheries (Uhlmann and Moller 2000, Uhlmann 2003). Others suggest that the decline could be linked with climate change (Spear and Ainley 1999).

3.1.4.4.2 Breeding Distribution and Chronology

Sooty Shearwaters breed during the austral summer at colonies in Australia and Tasmania, New Zealand (Antipodes, Auckland, Campbell, Chatham, Snares and Stewart Islands), southern Chile (Chiloe, Guafo and Guamblin Islands) and south of Cape Horn (Everett and Pitman 1993, Harrison 1987). Guafo Island, supporting an estimated four million birds, may be the largest seabird colony in the world (Reyes-Arriagada *et al.* 2007).

Although the following nesting cycle pertains to the New Zealand colonies, it apparently closely matches all known populations. Most breeders arrive at the colony in early September and eggs are laid in mid-November. After an incubation period of approximately 53 days, the majority of eggs hatch in mid-January. The chicks are attended by the parents until about the third week of April and then the adults depart; most of the chicks fledge between the last week of April and the first week of May (Warham *et al.* 1982, Everett and Pitman 1993).

3.1.4.4.3 Oceanic Distribution and Diet

Shaffer *et al.* (2006) recently resolved some of the broad-scale movements and habitat use of Sooty Shearwaters. By use of tracking data, they found that Sooty Shearwaters experience a perpetual cycle of spring, summer, and fall from year to year. When the shearwaters are at their

New Zealand colonies, they forage predominantly in cold Antarctic waters. Once breeding is completed, the shearwaters migrate to one of three areas in the western, central, or eastern N Pacific: the Kuroshio and Oyashio Currents region off Japan and Kamchatka Peninsula; the eastern Aleutian Islands and GOA region; or the California Current region. The timing of their arrival on the non-breeding grounds (generally late April/early May) occurs when oceanic productivity in the N Pacific exceeds that found in the S Pacific. By pursuing this ''endless summer", Sooty Shearwaters integrate peak oceanic resources on a global scale throughout the year; this has likely evolved as a way to deal with interannual variability.

At a smaller spatial scale, the at-sea distribution of Sooty Shearwaters appears to be associated with thermal gradients and upwellings. Depending on the location, the season and the scale studied, Sooty Shearwaters are either positively (Spear and Ainley 1999, Yen *et al.* 2005) or negatively (Vermeer *et al.* 1992) associated with sea-surface temperatures. They also tend to congregate along strong thermal gradients at the edge of upwellings (Briggs and Chu 1986). Wahl *et al.* (2005) described the Sooty Shearwater as the most abundant bird over the WA continental shelf, other than during winter. Although recorded in every month of the year, Sooty Shearwater numbers in WA begin to build in early May, and continue to increase through September. Vermeer *et al.* (1987a) reported flocks as large as 90,000 along the west coast of Vancouver Island in early May.

The diet of Sooty Shearwaters during the non-breeding season consists of small fish (especially capelin, lantern fish, lingcod, northern anchovy, Pacific herring, Pacific sandlance, Pacific saury, rockfish species,), small squid (e.g., *Loligo opalescens*), euphausiids (e.g., *Thysanoessa spinifera*), and offal (Chu 1984, Ogi 1984, Vermeer 1992, Gillespie and Westrheim 1997). During the breeding season, Sooty Shearwaters forage primarily for euphausiids (especially *Nyctiphanes australis*) and myctophid fish (Brooke 2004). Sooty Shearwaters capture their prey by underwater pursuit often to depths of 30-40 m, and occasionally to depths of almost 70 m (Weimerskirch and Sagar 1996, Shaffer *et al.* 2006).

3.1.4.4.4 Spatial Distribution and *Average Grid Cell Density* in Study Area

Sooty Shearwaters were observed throughout the entire spring season; they were concentrated along the shelfbreak, from Grays Harbor north along the west coast of Vancouver Island, to Cape Scott and Cook Bank. In the northern portion of the study area, Sooty Shearwaters were seen along the west coasts of Graham and Moresby Islands, in Dixon Entrance and Hecate Strait.

Offshore, Sooty Shearwaters occurred along Line P west to OSP, but were rarely encountered south of the Olympic Peninsula. The highest spring densities occurred about 10 km north of Graham Island (372.8 birds/km^2), and approximately 20 km west of Estevan Point (380.9 birds/km^2, driven by a large flock of an estimated 5,000 birds, seen on 13 May 1982). Other large groups encountered included a flock of about 4,300 birds (on 30 May 1995), approximately 25 km south of Cape Beale, and another flock of an estimated 3,000 birds (seen on 6 May 2000) roughly 55 km southwest of Cape Beale.

During summer, Sooty Shearwaters were found along the shelfbreak, especially off southwestern Vancouver Island and northern WA. Other areas of concentration included west of Cape Scott, Cook Bank, the eastern part of Queen Charlotte Sound near Calvert and Hunter Islands, Hecate Strait and Dixon Entrance. Summer observations of Sooty Shearwaters were of individuals, as well as small and large flocks. The largest aggregation was that of 1,500 birds (329.1 birds/km^2), seen at the mouth of Juan de Fuca Strait, on 26 June 2001. Offshore, birds were generally seen at low *average grid cell densities*. Although they were encountered out to OSP, relatively few were observed south of Line P.

During fall, the majority of Sooty Shearwaters were encountered within about 100 km of shore, although low numbers were encountered as far offshore as >800 km west of Moresby Island. The highest fall *average grid cell density*, (5 October 1996), was located east of Moresby Island.

Sooty shearwaters were recorded during winter on eight occasions. With the exception of a single bird seen east of OSP, all were found near or within Juan de Fuca Strait. The low number of Sooty Shearwaters during the boreal winter is to be expected; most birds should be at their S Hemisphere colonies during that time. The shearwaters that remain in the N Hemisphere are non-breeders (Harrison 1983).

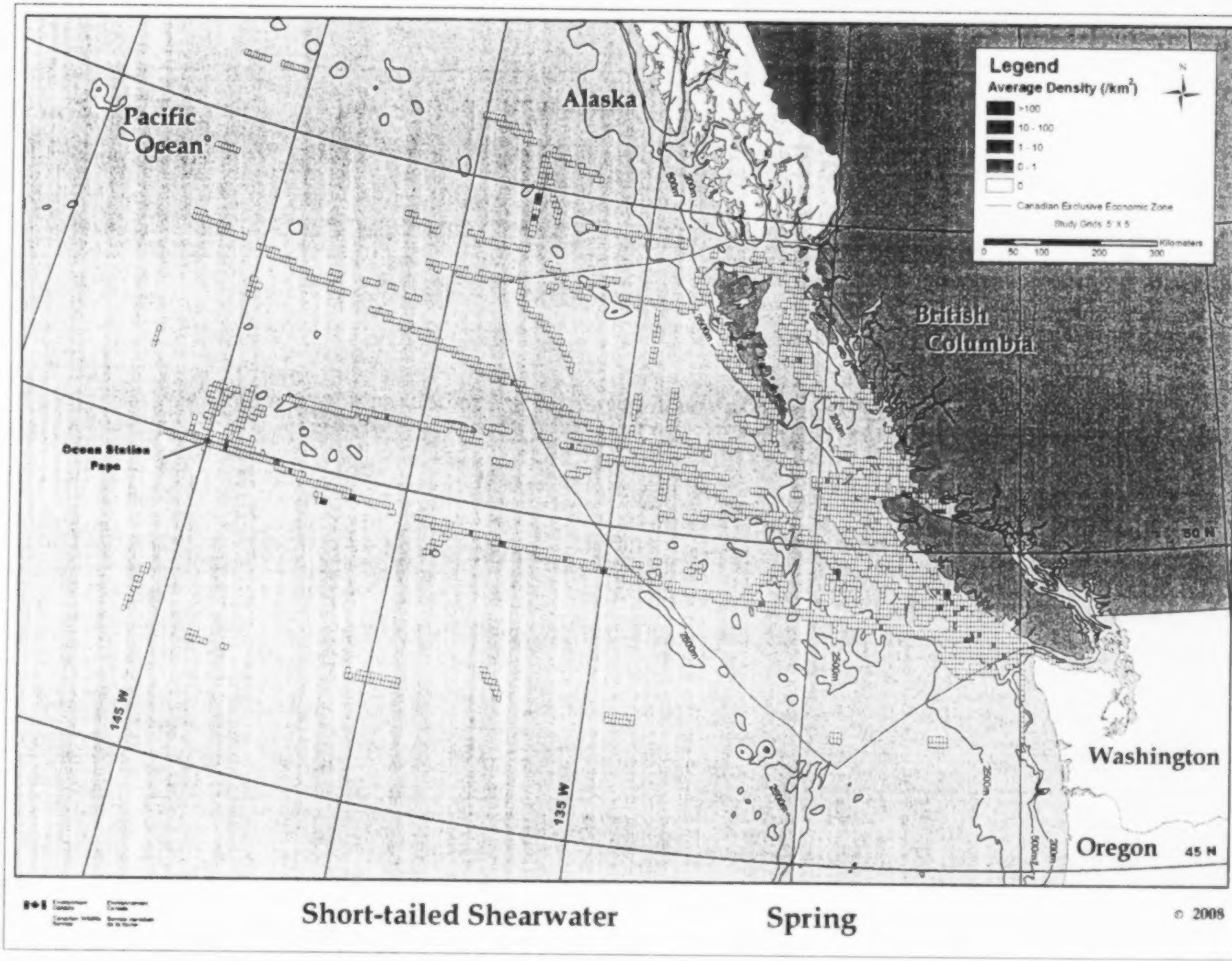

Figure 21A. Seasonal average grid cell densities of Short-tailed Shearwaters.

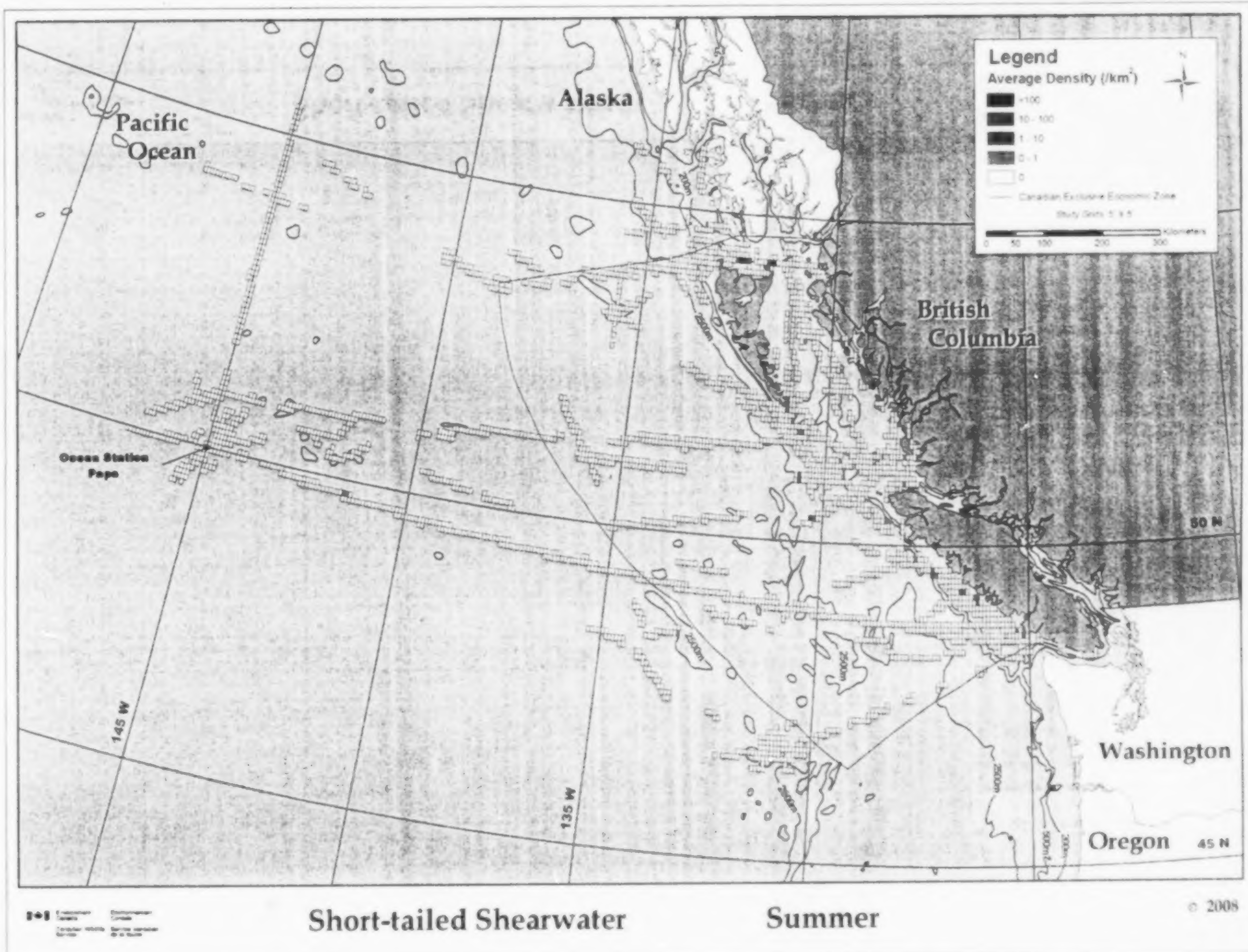

Figure 21B. Seasonal average grid cell densities of Short-tailed Shearwaters.

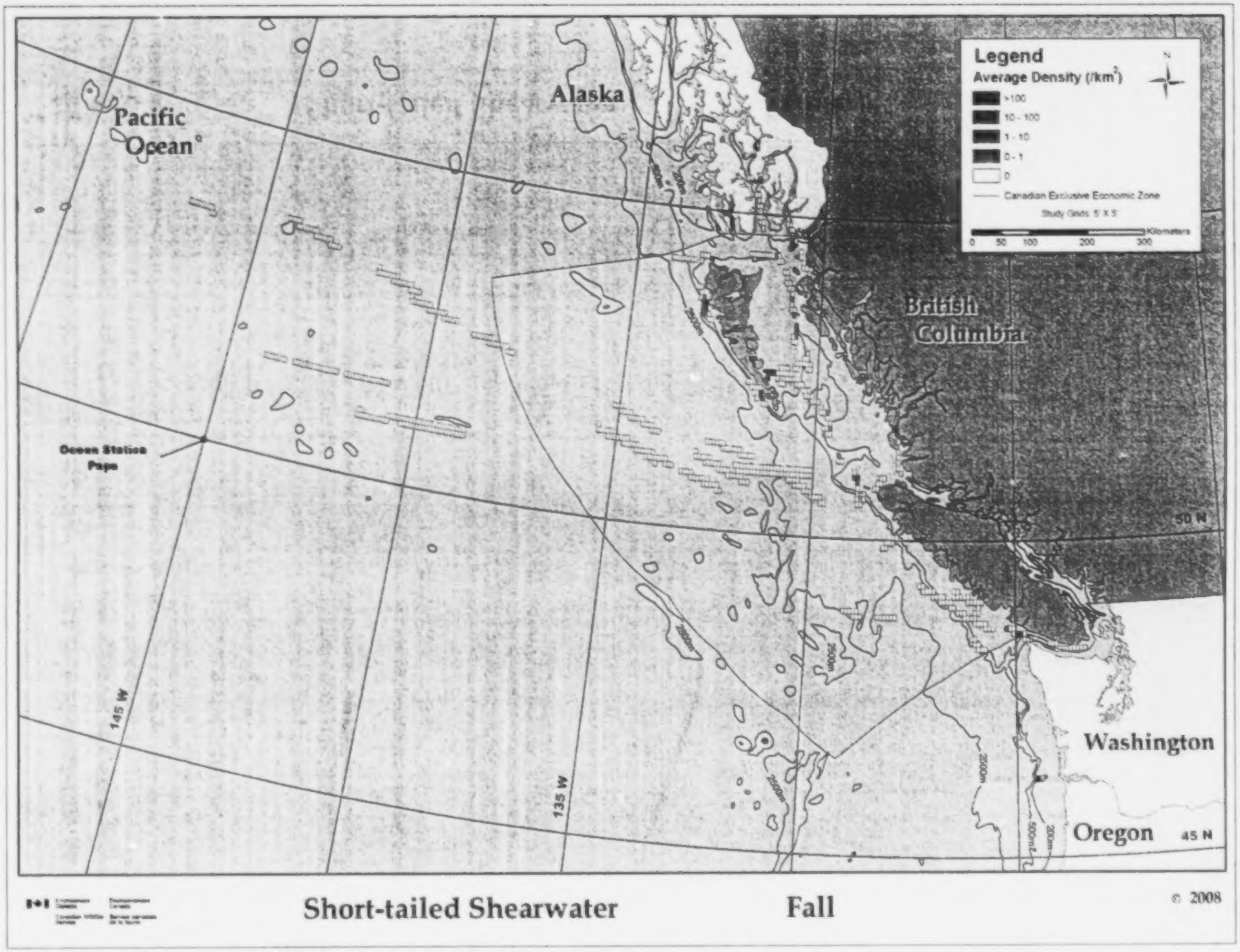

Figure 21C. Seasonal average grid cell densities of Short-tailed Shearwaters.

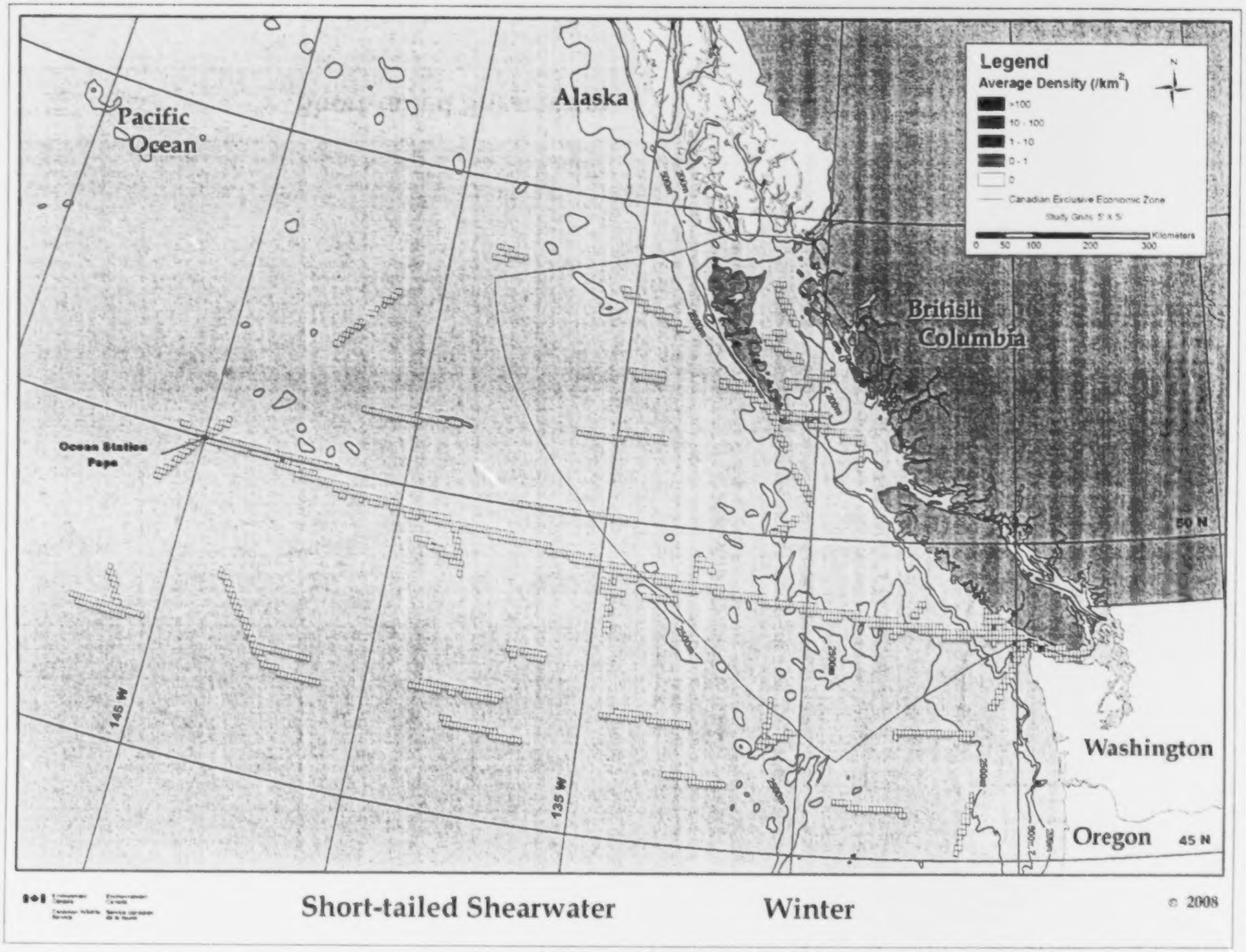

Figure 21D. Seasonal average grid cell densities of Short-tailed Shearwaters.

3.1.4.5 Short-tailed Shearwater *Puffinus tenuirostris*

3.1.4.5.1 Population and Conservation Status

With a global population of 23 million birds (Skira *et al.* 1986), the Short-tailed Shearwater is classified by the IUCN as a species of *Least Concern* (BirdLife International 2008), and is considered *Not Currently at Risk* in N America and Canada (Kushlan *et al.* 2002, Milko *et al.* 2003). Similar to the Sooty Shearwater, the conservation concern for this species is the incidental mortalities in commercial fisheries (Uhlmann 2003).

3.1.4.5.2 Breeding Distribution and Chronology

Short-tailed Shearwaters breed only in Tasmania and on islands in Bass Strait (Austin *et al.* 1994); there are >160 colonies in Tasmania, with an estimated 11.4 million burrows (Everett and Pitman 1993). Breeders arrive at the colonies in late September/early October and for approximately one month they are at the colony preparing their burrows. After a two-week honeymoon away from the colony, most eggs are laid in late November. Incubation lasts about 53 days, and after about 94 days in the burrows, chicks fledge between mid-April and early May (Serventy 1967, Skira *et al.* 1986). During the breeding season, the distance that breeders fly from the colony depends on the foraging goal (Weimerskirch and Cherel 1998). Adults foraging for their chicks make short (35-70 km, Einoder and Goldsworthy 2005) excursions, whereas self-maintenance trips may be up to 15,000 km long (Klomp and Schultz 2000).

3.1.4.5.3 Oceanic Distribution and Diet

Short-tailed Shearwaters range from southern Australian and New Zealand waters, north through the Pacific Ocean to the Bering and Chukchi Seas, as well as into the western Beaufort Sea (Johnson and Herter 1989) and south along the west coast of N America to Baja California, MX (Harrison 1983).

Wahl *et al.* (2005) reported that Short-tailed Shearwaters have been observed in WA in all months other than June. Peak numbers occurred there in April and again from late September to mid-November. Short-tailed Shearwaters in AK are associated with tidal fronts where they forage on euphausiid swarms during summer (Hunt *et al.* 1996). Logerwell and Hargreaves (1996) noted that proximity to fronts had a weak but significant positive effect on the abundance of shearwaters (Short-tailed and Sooty) off the west coast of Vancouver Island.

Adult Short-tailed Shearwaters feed upon euphausiids (e.g., *Thysanoessa rashii*), copepods, amphipods (e.g., *Parathemisto libellula*), small squid and larval fish (Ogi *et al.* 1980, Vermeer *et*

al. 1992, Weimerskirch and Cherel 1998, Connan *et al.* 2005, Jahncke *et al.* 2005). During the pre-egg laying part of breeding season (September and October) the diet of Short-tailed Shearwaters is primarily crustaceans. However, during the chick-rearing stage (February to April), the proportion of crustaceans declines with fish becoming the major prey category (Montague *et al.* 1986).

3.1.4.5.4 Spatial Distribution and *Average Grid Cell Density* in Study Area

During at-sea surveys, Short-tailed Shearwaters are notoriously difficult to tell apart from Sooty Shearwaters, and as a result, the two species are often grouped together as "dark shearwaters" (Harrison 1983, Morgan *et al.* 1991, Burger 2003). We therefore caution the reader that the Short-tailed Shearwater densities we report here may underestimate their actual numbers. To illustrate this point, we note that despite conducting numerous at-sea surveys off the BC coast (April and July 1975, June 1976, May, July and September 1977, May and October 1978) J.R. Guzman failed to identify a single Short-tailed Shearwater (Guzman and Myres 1983); however, they did describe a previously unpublished observation of high numbers of Short-tailed Shearwaters over Swiftsure Bank. The observer (P.W. Martin) encountered on 19 May 1972, a concentration of Short-tailed Shearwaters that was "*...at least 15 miles across and contained hundreds of thousands of individuals*". Martin collected a specimen, and the species' identification was confirmed.

Although Short-tailed Shearwaters were never abundant within the study area, and with above caveat noted, they did appear to be widely distributed during spring. There were 50 observations of Short-tailed Shearwaters during spring surveys; however, there were no *average grid cell density* >2.6 birds/km^2. Birds were distributed inshore of the shelfbreak, from about 45 km south of Cape Beale to almost 30 km west of Estevan Point. In addition, Short-tailed Shearwaters were encountered offshore, from around 115 km southwest of Brooks Peninsula out almost to OSP. During summer, Short-tailed Shearwaters were encountered 35 times within the study area; most sightings were of individuals or pairs, although there were a few larger flocks (maximum observed 31 birds). The highest *average grid cell densities* (up to 5.8 birds/km^2) were located north of Graham Island. Overall, these shearwaters were scattered at low densities and primarily within 250 km of land. The farthest from land a Short-tailed Shearwater was encountered during summer was approximately 745 km west, southwest of Moresby Island.

There were fewer encounters of Short-tailed Shearwaters during fall, and most of the 28 sightings were north of 50° N. All birds were seen within 100 km of land.

Short-tailed Shearwaters were rarely seen during winter surveys; they were only encountered on six occasions. With the exception of a sighting out near OSP, all of the remaining sightings were associated either with Juan de Fuca Strait or Amphitrite Bank.

3.1.5 Storm-Petrels

Fork-tailed Storm-Petrel (*Oceanodroma furcata*).
© Mike Yip.

Storm-Petrels (*Hydrobatidae*) are the smallest of the *Procellariiformes*. Some species are abundant and widely distributed throughout several oceans; others are abundant only in localized areas (Harrison 1983). In BC, Fork-tailed and Leach's Storm-Petrels are the only species that are regularly encountered. Campbell *et al.* (1990a) noted that the Least Storm-Petrel (*Oceanodroma microsoma*) has been observed in the province (no details provided). A fourth species, Wilson's Storm-Petrel (*O. oceanicus*), might also occur in BC waters. According to Wahl *et al.* (2005) there are at least three records from WA, including one seen "…*about 48 km w-nw of Grays Harbor on 23 July 1984*…" or an estimated 150 km from Canadian waters. This S Hemisphere breeder has also been regularly observed off central CA in recent years (Wahl *et al.* 2005).

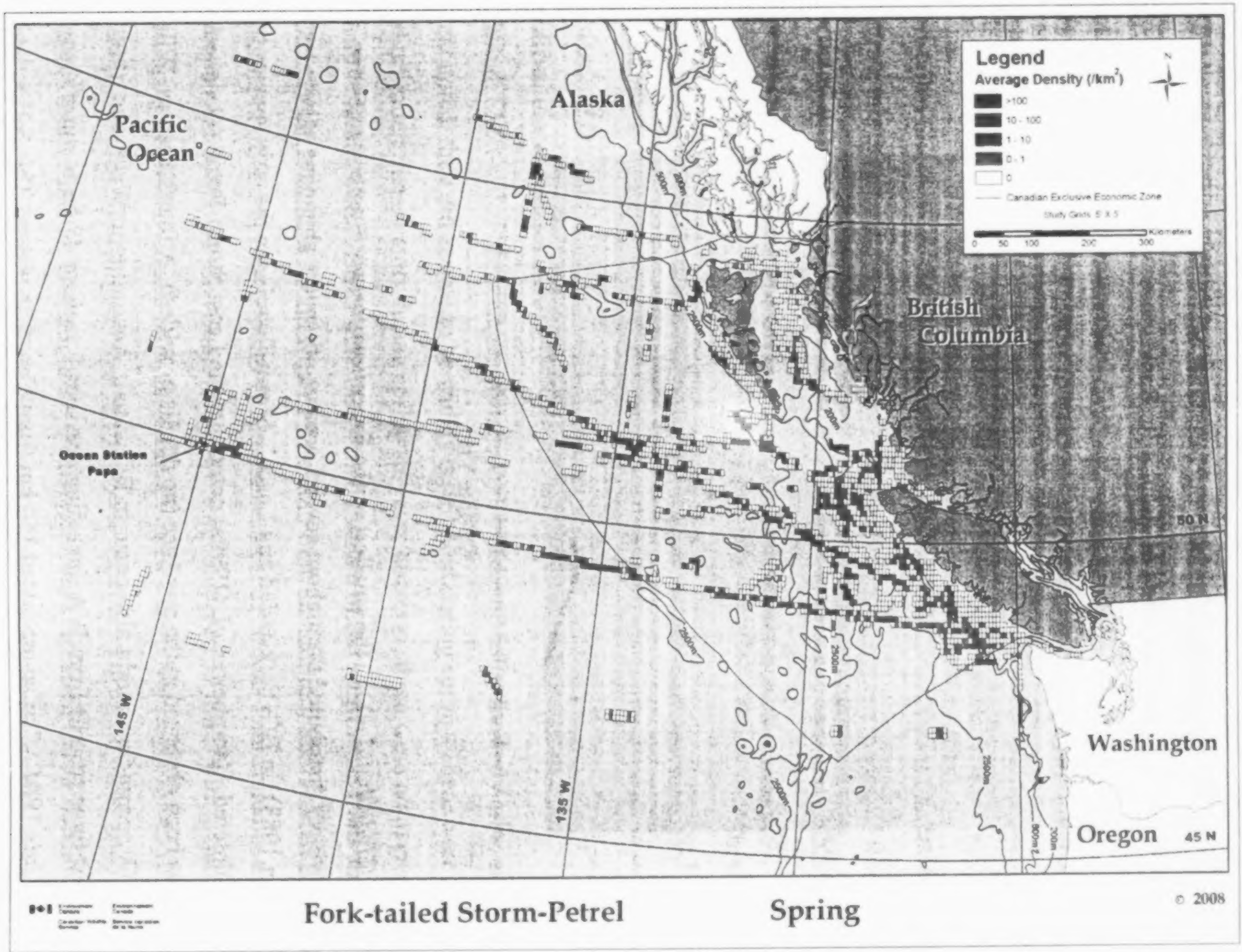

Figure 22A. Seasonal average grid cell densities of Fork-tailed Storm-Petrels.

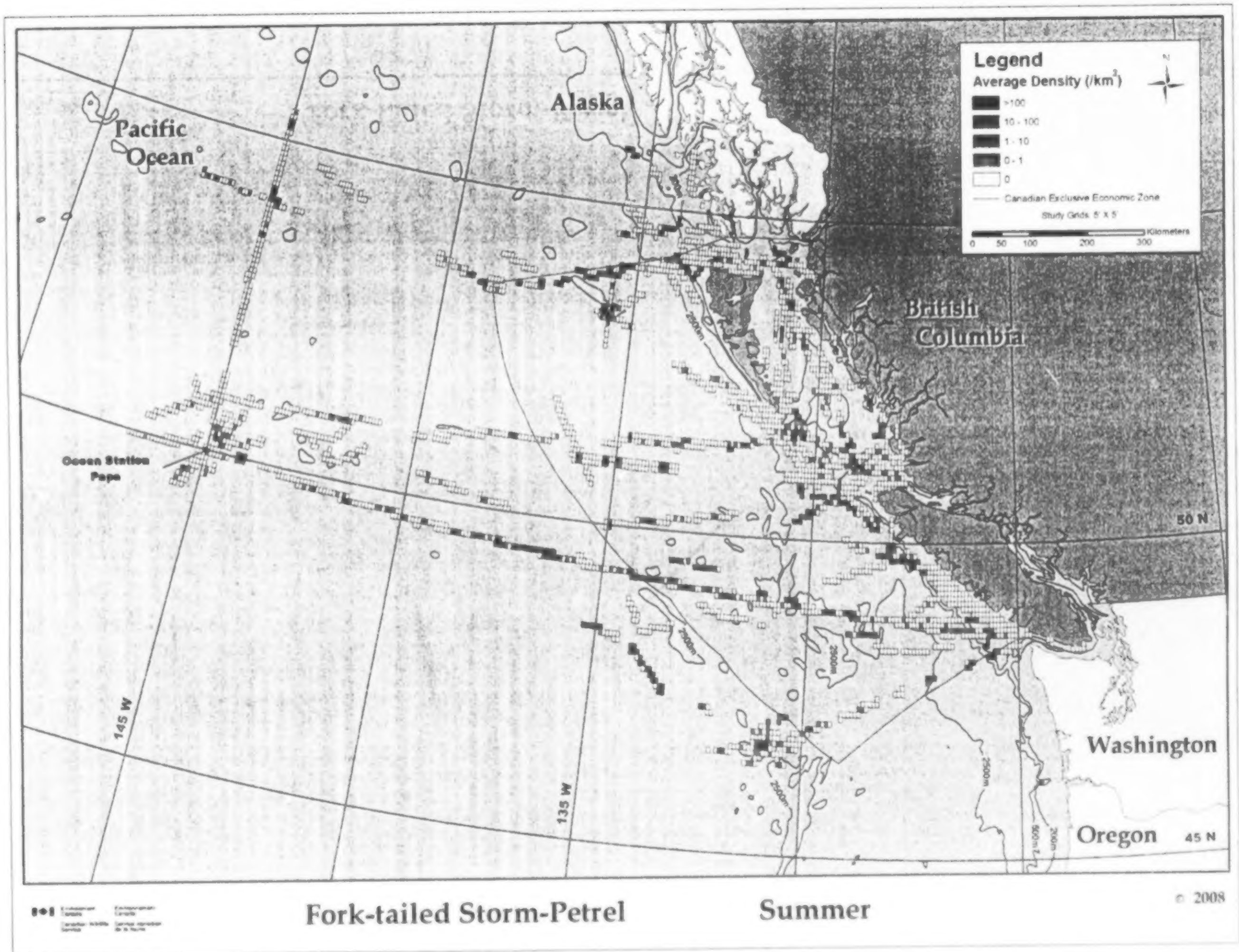

Figure 22B. Seasonal average grid cell densities of Fork-tailed Storm-Petrels.

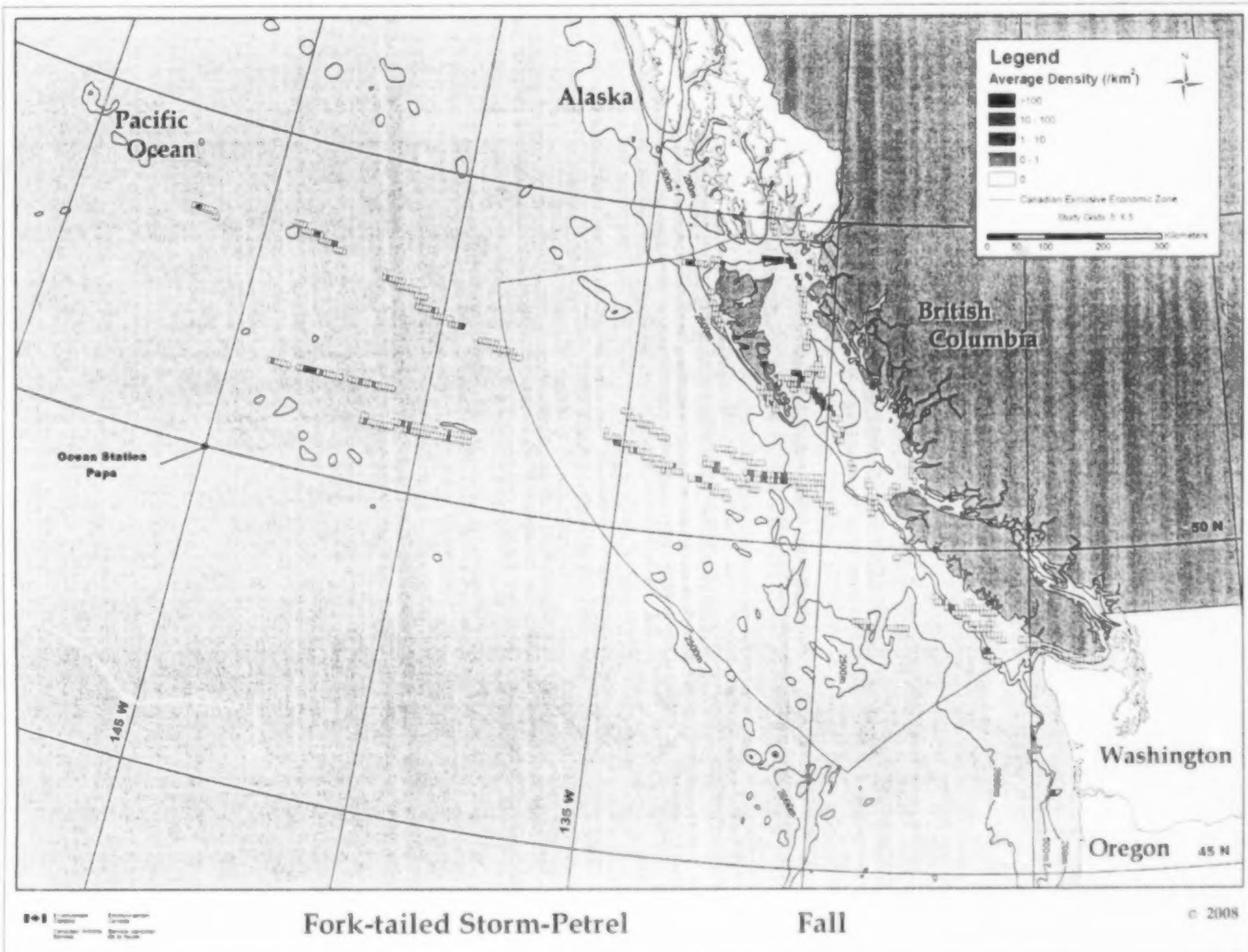

Figure 22C. Seasonal average grid cell densities of Fork-tailed Storm-Petrels.

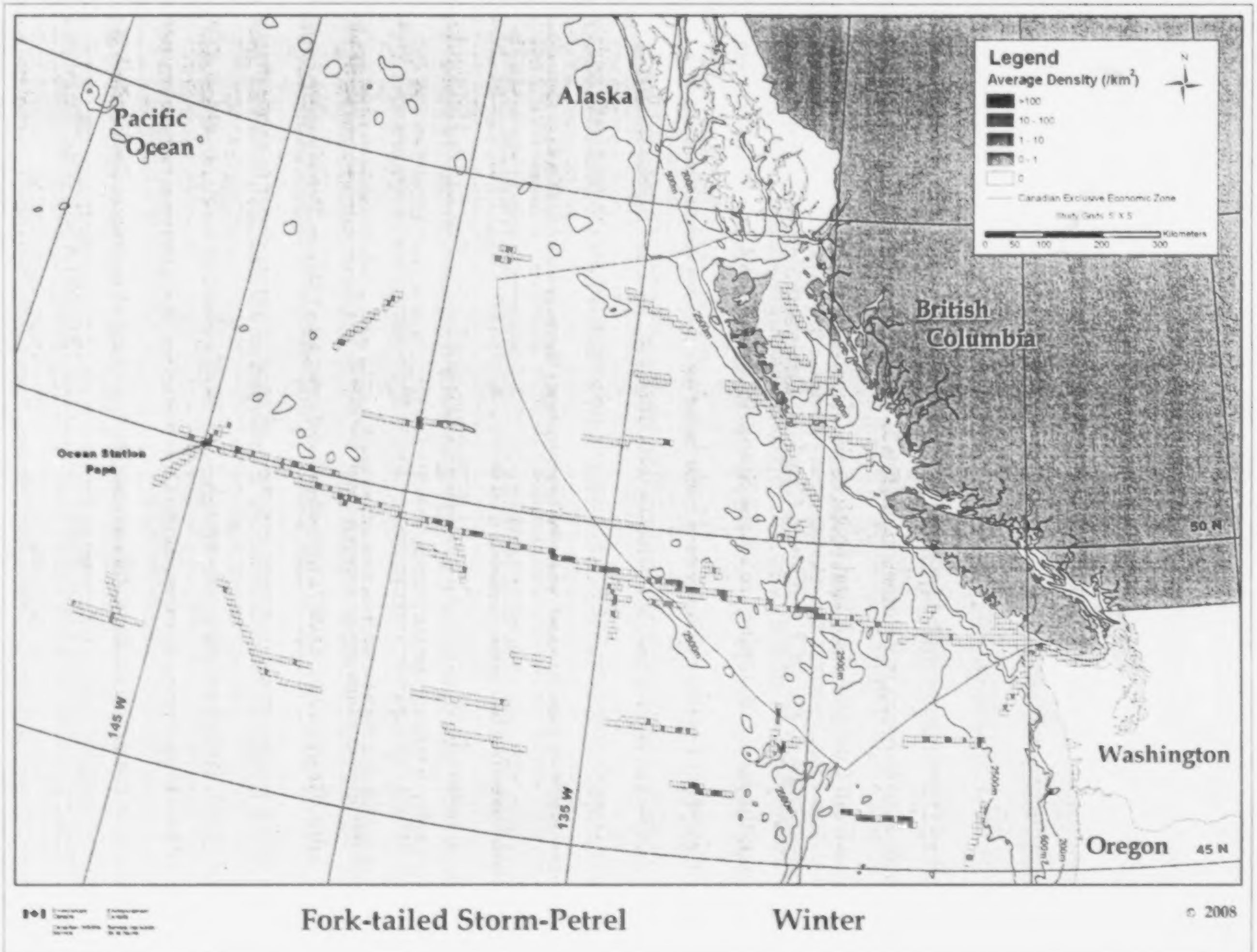

Figure 22D. Seasonal average grid cell densities of Fork-tailed Storm-Petrels.

3.1.5.1 Fork-tailed Storm-Petrel *Oceanodroma furcata*

3.1.5.1.1 Population and Conservation Status

Estimated to number between five and 10 million worldwide, the Fork-tailed Storm-Petrel is one of the most abundant storm-petrels (Boersma and Silva 2001). They are considered to be globally a species of *Least Concern* (BirdLife International 2008, BCCDC 2006) and *Not Currently at Risk* in N America and Canada by Kushlan *et al.* (2002) and Milko *et al.* (2003) (respectively). Rodway (1991) estimated that BC supported a breeding population of 380,000 Fork-tailed Storm-Petrels; whereas, Boersma and Groom (1993) placed the provincial population between 300,000 and 1,300,000 birds.

3.1.5.1.2 Breeding Distribution and Chronology

Fork-tailed Storm-Petrels breed in colonies along the N Pacific, from the Aleutian Islands, to northern CA, and from Commander Island south to the Kuril Islands. In BC, colonies are located along the northwest coast of the QCI, in Queen Charlotte Strait and along the west coast of Vancouver Island; the largest colonies are on the Storm Islets and the Gillam Islands (Rodway 1991). In the northeast N Pacific, eggs are laid from late April to late May, and fledging and dispersal occur from August through September (Boersma *et al.* 1980). Fork-tailed Storm-Petrels nesting in BC are thought to return to the colonies in April, eggs are laid during May and June, and fledging takes place in late August or early September (Vermeer *et al.* 1988).

3.1.5.1.3 Oceanic Distribution and Diet

At sea, the species ranges from central CA to AK, through the Bering Sea and to Hokkaido, Japan (Harrison 1983). They are known to occur over continental shelf, slope, and offshore waters (Boersma and Silva 2001), and to associate with steep sea-surface temperature gradients (O'Hara *et al.* 2006). Briggs *et al.* (1987) reported that Fork-tailed Storm-Petrels were usually found seaward of the coolest coastal waters, but were generally found closer to shore than Leach's Storm-Petrels (*Oceanodroma leucorhoa*). In contrast, Morgan (1997) noted in a July crossing of the GOA (from Prince Rupert, BC to Dutch Harbor, AK) that the two storm-petrel species occurred over the entire route at approximately the same abundance. Fork-tailed Storm-Petrels were present in the northern GOA during each cruise (March, April, May, October and December), but were least numerous from December to April; they apparently completely abandoned nearshore waters in December and March (Day 2006).

Vermeer *et al.* (1992) found that off the west coast of Vancouver Island, Fork-tailed Storm-Petrels were associated with cold, lower salinity, shelf waters during summer; whereas, in spring they were more frequently associated with warmer and more saline waters, at or seaward of the shelfbreak. Yen *et al.* (2005) observed that along Line P, Fork-tailed Storm-Petrels occurred at higher densities in proximity to land and to steep bottom topography; and, displayed positive associations with chlorophyll *a* concentration in the coastal region.

Fork-tailed Storm-Petrels catch their prey near the water surface; important food items include small squid, larval fish (e.g., capelin, greenling, myctophids, Pacific sandlance, rockfish species, sablefish), amphipods (e.g., *Paracallisoma coecus*, *P. alberti*), copepods (*Neocalanus cristatus*), euphausiids (e.g., *Thysanoessa spinifera*, *Euphausia pacifica*), crab larva, isopods and shrimp (DeGange and Sanger 1986, Vermeer and Devito 1988, Vermeer 1992). Some of their food is obtained by stealing it from Leach's Storm-Petrels (Morgan 1994).

3.1.5.1.4 Spatial Distribution and *Average Grid Cell Density* in Study Area

Fork-tailed Storm-Petrels were found in the study area in all seasons, distributed throughout the surveyed area, commonly along the outer shelf (see also Morgan *et al.* 1991) but also offshore to OSP; birds were encountered from AK to WA, and usually either as individuals or pairs.

In spring, Fork-tailed Storm-Petrels were seen from April through mid-June and were widely distributed throughout the survey area, particularly over the outer shelf west of Vancouver Island, as well as in Queen Charlotte Sound and Hecate Strait. Birds were encountered offshore in the northern sub-region to approximately 715 km west of AK, and in the southern sub-region to approximately 1,190 km west of the Olympic Peninsula; as well as to OSP and beyond. The highest spring *average grid cell densities* were located approximately 65 km west of the Olympic Peninsula (20.5 birds/km^2), and roughly 400 km west of Queen Charlotte Sound.

During summer, Fork-tailed Storm-Petrels were commonly encountered and again were widely distributed throughout the study area. The highest *average grid cell densities* occurred over Bowie Seamount (43.6 birds/km^2, a result of encountering an estimated 500 birds on 4 August 2000 in association with several fishing vessels); and approximately 70 km west of Cape Flattery (58.0 birds/km^2, when 257 birds were seen on 1 July 1997). In addition, Fork-tailed Storm-Petrels occurred at elevated *average grid cell densities* over Cobb Seamount

During fall, Fork-tailed Storm-Petrels were not commonly encountered (maximum *average grid cell density* ≤4.3 birds/km^2). Birds were observed in Hecate Strait and Dixon Entrance as well as scattered offshore, out to approximately 875 km west of Graham Island.

Winter sightings of Fork-tailed Storm-Petrels were from January through March, with the majority seen in February (when most winter survey effort occurred). Most birds were encountered well beyond the shelfbreak (see also Morgan *et al.* 1991) at low *average grid cell densities* (≤2.3 birds/km^2). The only birds seen over the shelf were found at the entrance to Juan de Fuca Strait. Similar to that noted during summer, the highest winter *average grid cell density* (2.4 birds/km^2) was associated with a seamount (Cobb).

This species has also been observed in BC during every month (Campbell *et al.* 1990a). Peak numbers in BC are from May through September (>90 % of all records, Campbell *et al.* 1990a).

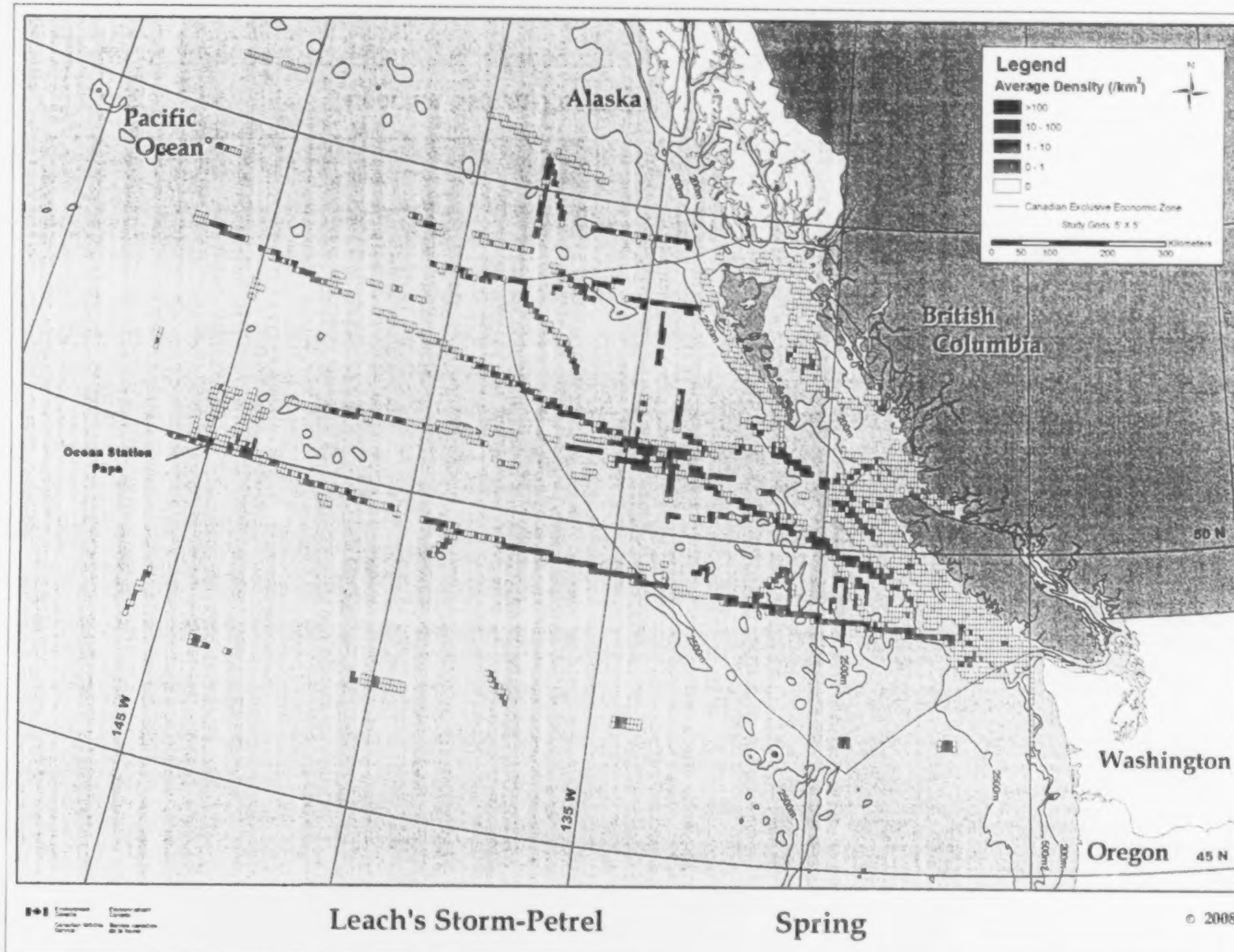

Figure 23A. Seasonal average grid cell densities of Leach's Storm-Petrels.

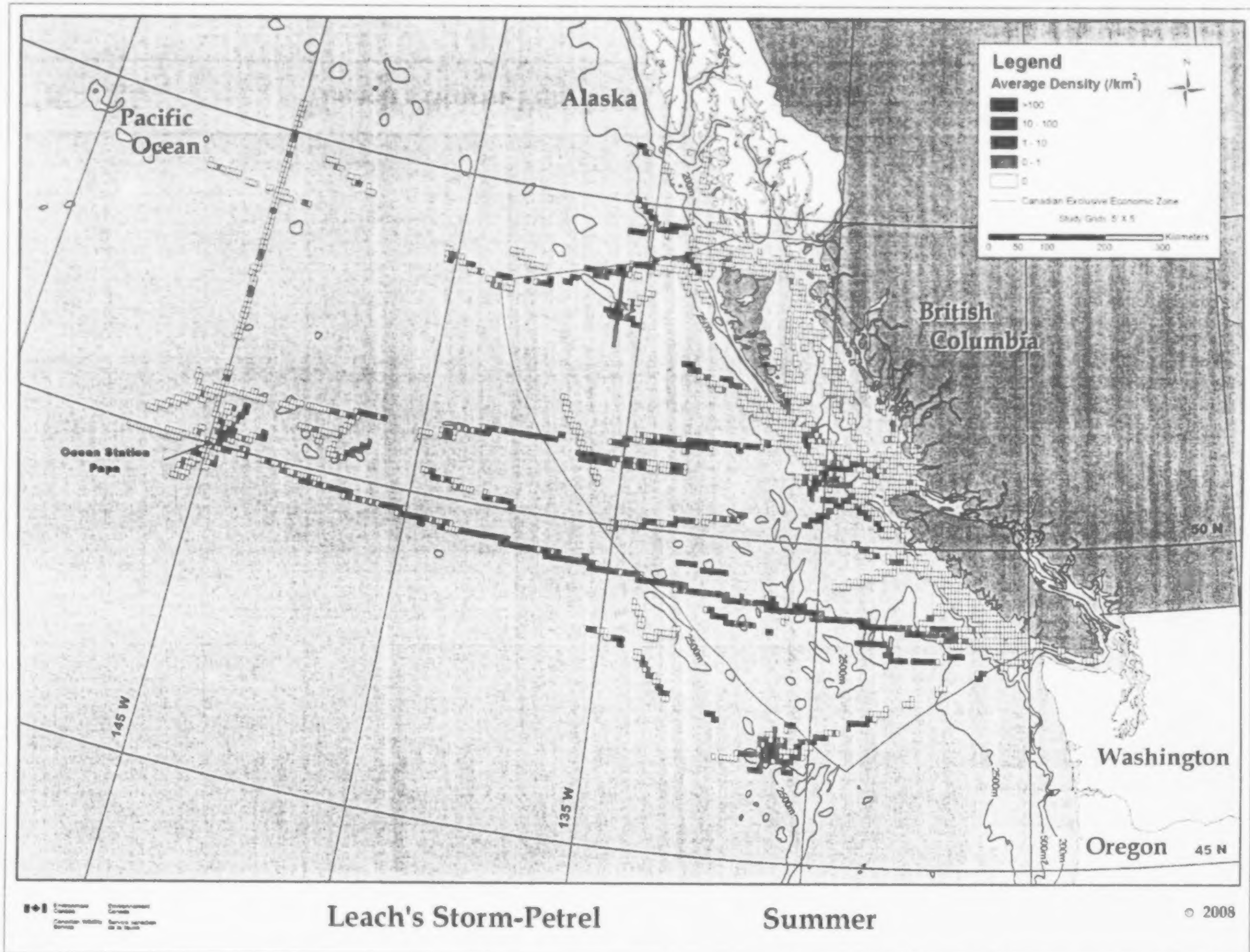

Figure 23B. Seasonal average grid cell densities of Leach's Storm-Petrels.

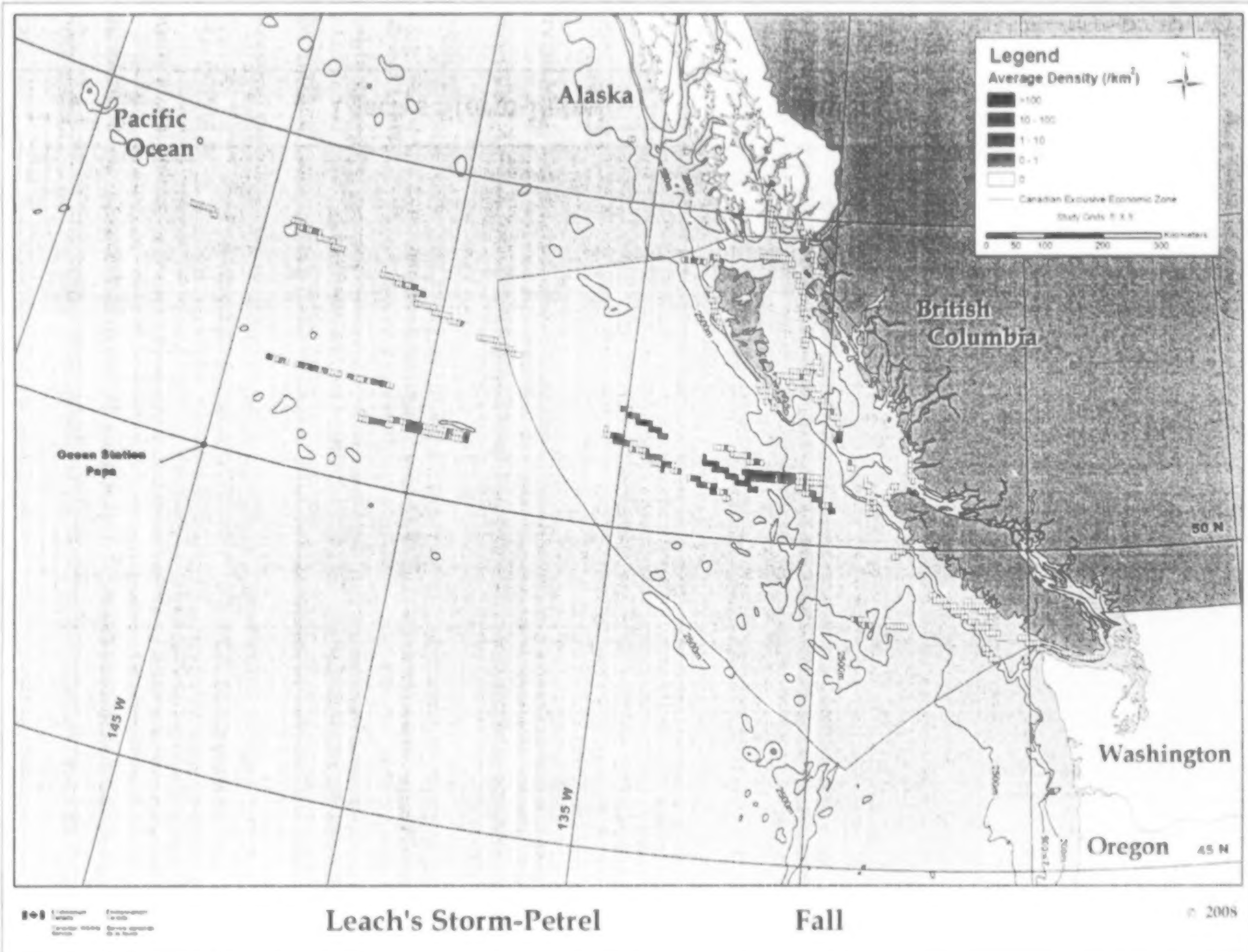

Figure 23C. Seasonal average grid cell densities of Leach's Storm-Petrels.

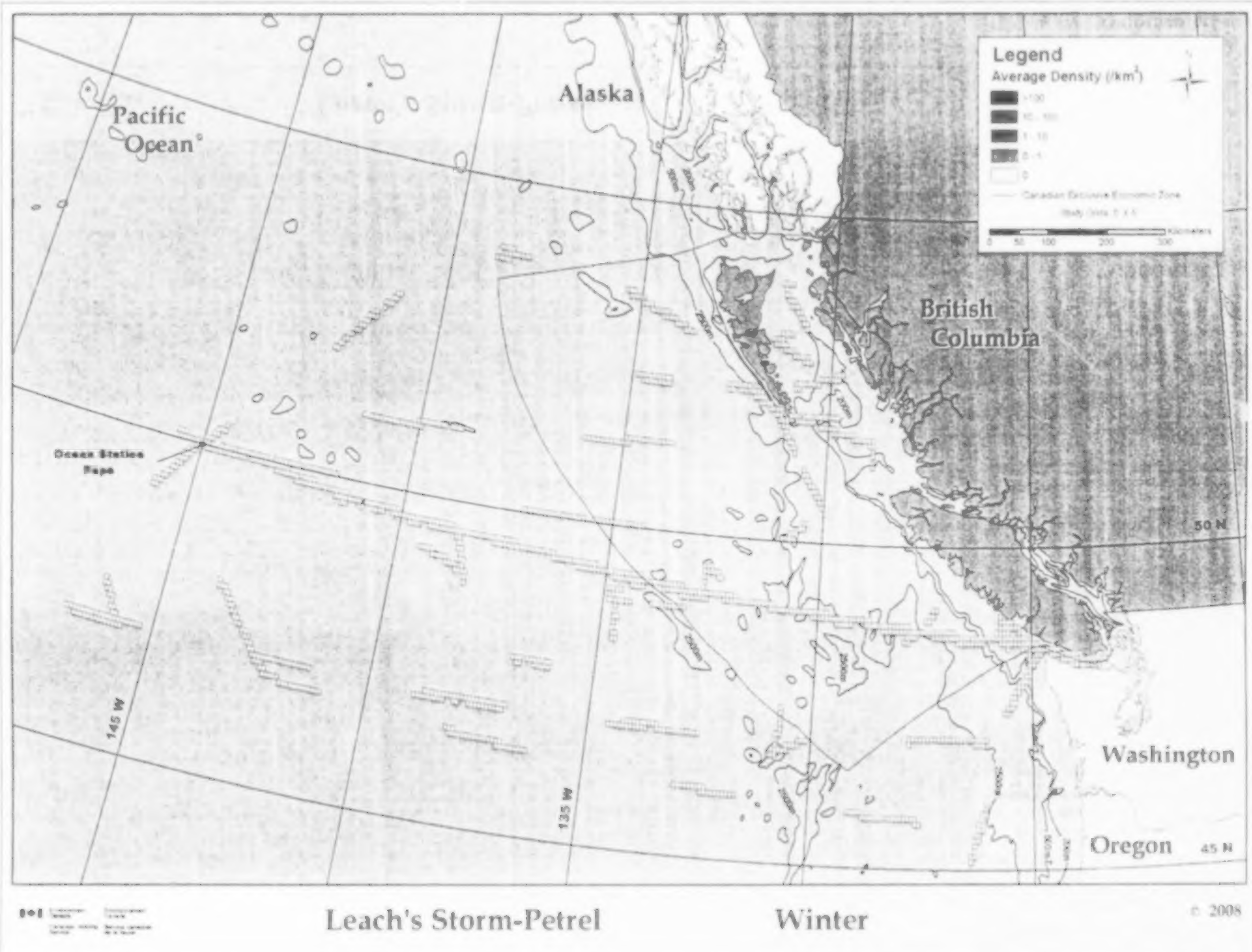

Figure 23D. Seasonal average grid cell densities of Leach's Storm-Petrels.

3.1.5.2 Leach's Storm-Petrel *Oceanodroma leucorhoa*

3.1.5.2.1 Population and Conservation Status

The global breeding population of Leach's Storm-Petrels is estimated at >eight million birds; including non-breeders the total population may be between 10 and 15 million individuals (Boersma and Groom 1993, Huntington et al. 1996). The IUCN lists the Leach's Storm-Petrel as a species of *Least Concern* globally (BirdLife International 2008). They are listed by Kushlan *et al.* (2002) as a species of *Low Conservation Concern* for N America; whereas, Milko *et al.* (2003) list the species as of *High Conservation Concern* in Canada.

3.1.5.2.2 Breeding Distribution and Chronology

Leach's Storm-Petrels are widespread, occurring in the N and S Pacific, the N and S Atlantic and occasionally in the Indian Ocean (Harrison 1983). They nest from Hokkaido, Japan, through the Aleutian Island and south along the west coast of N America to Baja California. They are a very abundant breeder in eastern Canada, and they also nest (in smaller numbers) off the coast of Great Britain (Harrison 1983, Boersma and Groom 1993, Huntington *et al.* 1996). The world's largest Leach's Storm-Petrel colony is Baccalieu Island (Newfoundland [NL]), where an estimated 3.36 million pairs nest (Sklepkovych and Montevecchi 1989).

In BC, over 550,000 pairs nest at >40 sites (Rodway 1991). Although egg-laying may occur as early as May, Vermeer *et al.* (1988) reported that most eggs are laid in July. Hatching occurs primarily in August, and fledging and post-breeding dispersal occurs from September to November.

3.1.5.2.3 Oceanic Distribution and Diet

Leach's Storm-Petrels are often associated with fronts or eddies (where prey tend to concentrate at the surface); and usually, they are more numerous seaward of the continental slope, associating with warmer and more saline waters (Vermeer and Rankin 1984, Morgan *et al.* 1991). Along Line P, Leach's Storm-Petrel density was positively associated with chlorophyll *a* concentration, in both coastal and oceanic zones (Yen *et al.* 2005).

Wahl *et al.* (2005) reported low winter numbers in offshore areas (February) and slightly higher inshore numbers (December and January). This is consistent with the southward migration of this species to its southern wintering grounds (Harrison 1983). N Pacific nesting Leach's Storm-Petrels overwinter mostly in the western, central or eastern tropical Pacific; although a few remain in the GOA. Rintoul *et al.* (unpubl. 2006) reported good numbers of Leach's Storm-

Petrels off southern CA during winter surveys (5 January to 11 March). There are scattered winter records from the Galapagos Islands, Australia and New Zealand (Harrison 1983, Anonymous 2006).

During the nesting season, Leach's Storm-Petrels Birds forage widely, often hundreds of kilometres from their nest sites; capturing at or near the surface small fish (especially myctophids), amphipods (e.g., *Paracallisoma coecus*), euphausiids (e.g., *Euphausia pacifica*), jellyfish (e.g., *Velella velella*), crustaceans and small squid (Vermeer and Devito 1988, Vermeer 1992, Montevecchi *et al.* 1992, Huntington *et al.* 1996). They generally forage singly or in small groups, but are known to occur in large, mixed-species flocks (Huntington *et al.* 1996, Briggs *et al.* 1987).

3.1.5.2.4 Spatial Distribution and *Average Grid Cell Density* in Study Area

We found Leach's Storm-Petrels to be abundant in BC waters during spring and summer, somewhat less numerous in fall, and rare during winter. They were common along the shelfbreak and offshore throughout the study area, from AK to WA, and west along Line P to and beyond OSP. In contrast to the pattern noted in the first atlas (Morgan *et al.* 1991), this species was frequently observed north of Cape St. James; we do not know if that represents a shift in the at-sea distribution of Leach's Storm-Petrels, or if it is an artefact of the timing and location of more recent surveys.

Leach's Storm-Petrels were distributed primarily offshore throughout the study area during spring, occurring both north and south of Line P. Highest spring *average grid cell densities* (up to 99.3 birds/km^2), were 350 to 380 km west of Cape St. James; they were seen in the second week of June (i.e. the end of spring). Moderate *average grid cell densities* (higher than 20.0 birds/km^2) occurred west of the northern end of Vancouver Island, as well as northwest of Langara Island. The largest group of Leach's Storm-Petrels observed during spring (138 birds) was encountered (on 2 June 2004) approximately 135 km west of Brooks Peninsula.

Similar to the pattern presented during spring, Leach's Storm-Petrels were encountered almost exclusively offshore throughout the study area in summer; from AK to WA, and as far west as approximately 146° W. The largest group encountered in summer was of an estimated 300 birds seen near fishing vessels on 4 August 2000, over Bowie Seamount (*average grid cell density* 36.5 birds/km^2). Other locations with higher *average grid cell densities* included the edge of Cook Bank (24.4 birds/km^2), and roughly 125 km northwest of Langara Island (31.9 birds/km^2).

During fall, Leach's Storm-Petrels were rare south of Cape Scott (as were offshore surveys). The majority of birds were encountered to the west of Queen Charlotte Sound; the highest *average grid cell density* was found to be approximately 150 km southwest of Cape St. James. Birds were observed in the offshore as far as 144° W or approximately 780 km west of Graham Island. Leach's Storm-Petrels were essentially absent from the study area during winter. We encountered only a single bird during winter, seen on 25 February 2004, >740 km west, southwest of Cape St. James. The rarity of Leach's Storm-Petrels from the study area mirrors what others have reported. Morgan *et al.* (1991) noted seeing only three birds (February and early March) during approximately 1500 km of winter surveys.

3.1.6 Phalaropes

Red-necked Phalarope (*Phalaropus lobatus*).
© Carsten Egevang / ARC-PIC.COM.

Phalaropes are small shorebirds that are functionally seabirds. Of the world's three species; two, the Red Phalarope and the Red-necked Phalarope, use the marine environment extensively for much of the year. Both species breed in the Arctic, and migrate through the study area to and from their sub-tropical and tropical wintering grounds.

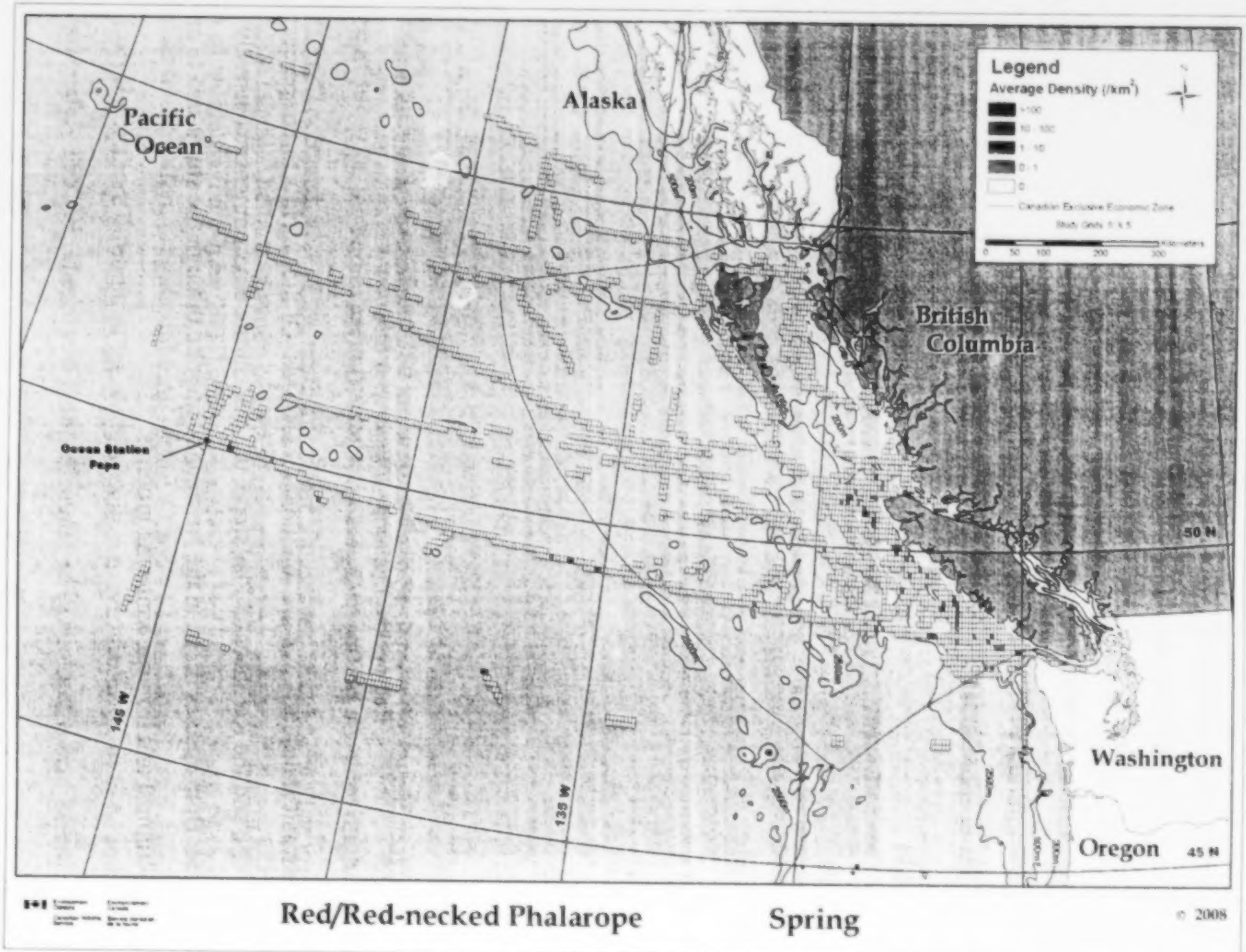

Figure 24A. Seasonal average grid cell densities of Red/Red-necked Phalaropes.

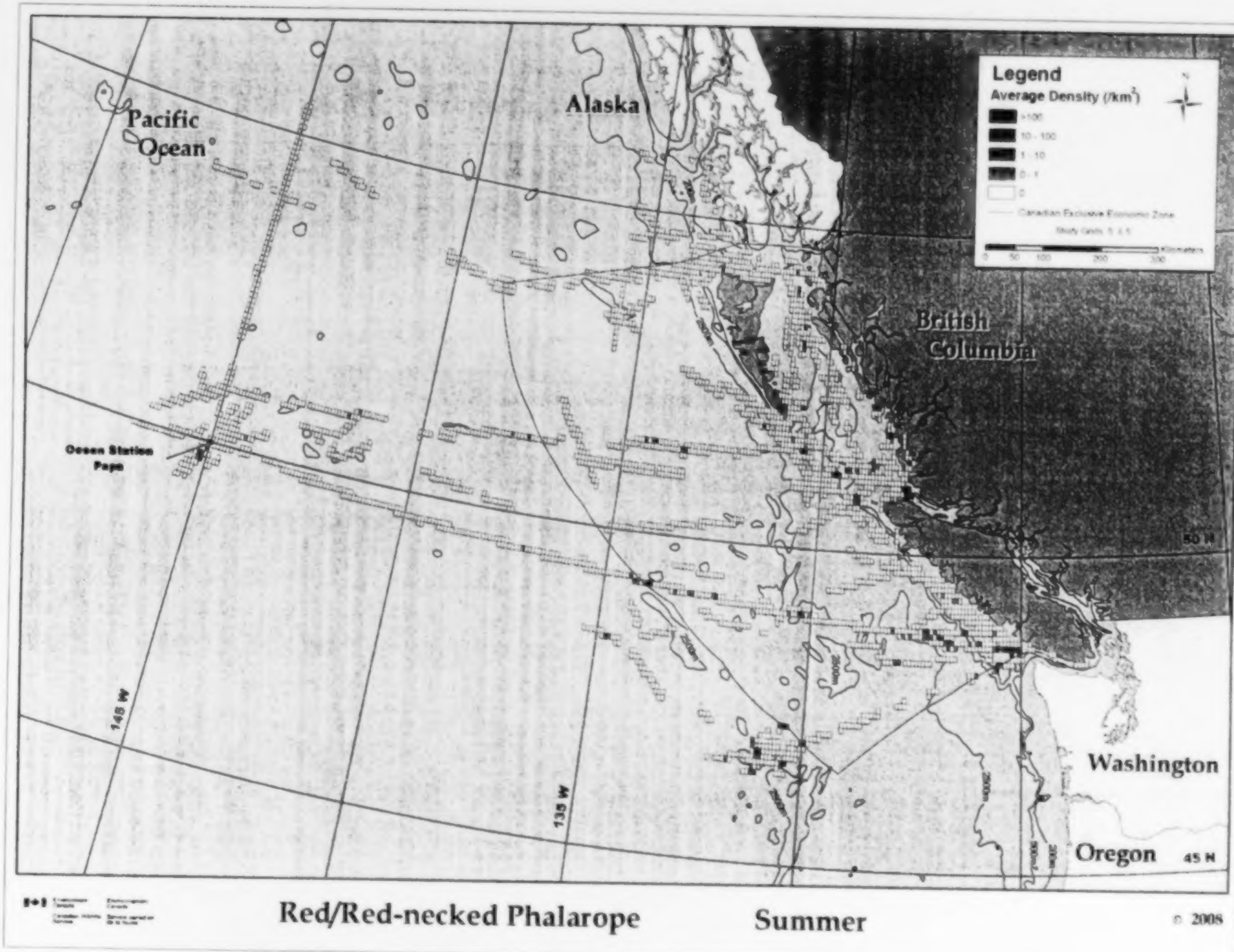

Figure 24B. Seasonal average grid cell densities of Red/Red-necked Phalaropes.

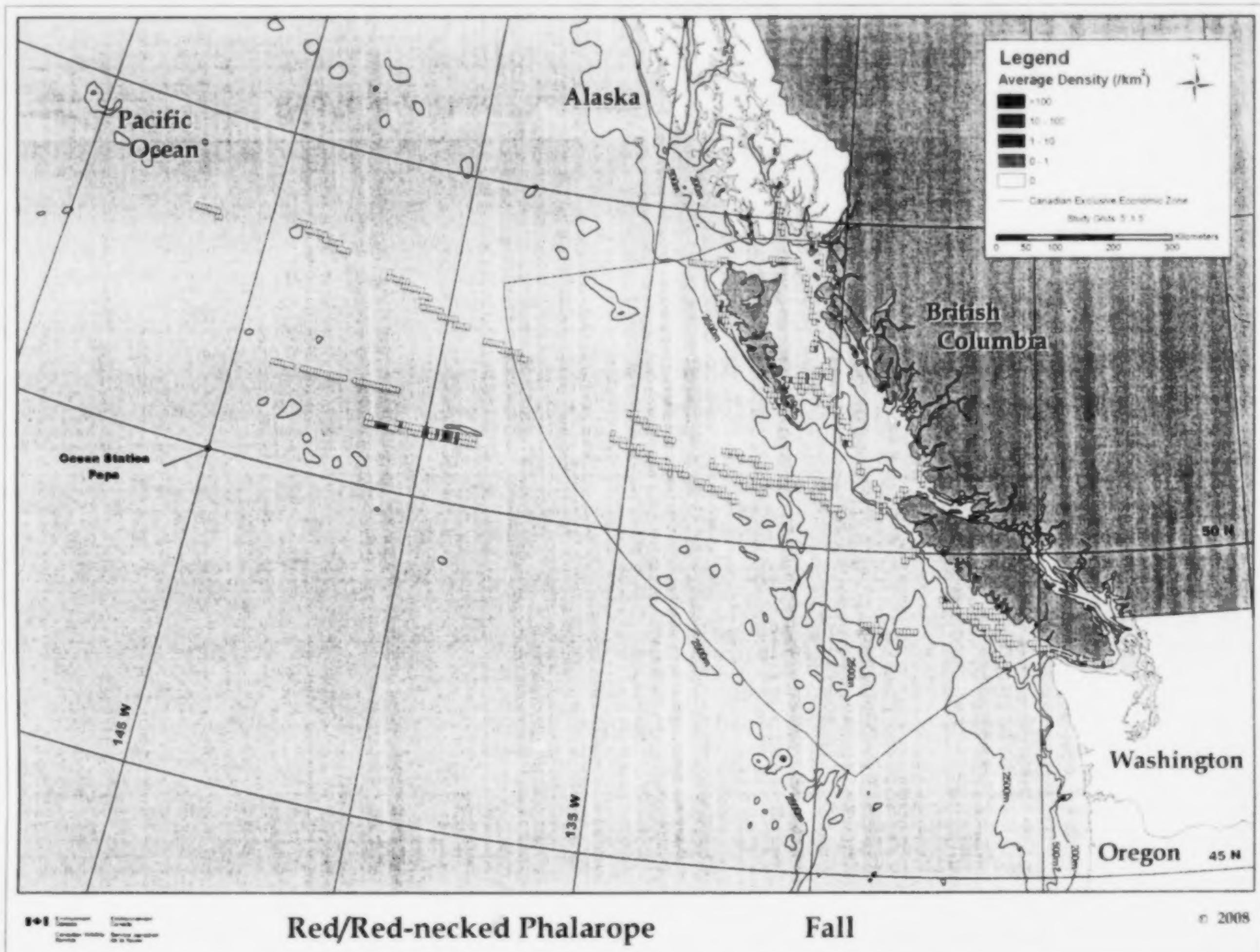

Figure 24C. Seasonal average grid cell densities of Red/Red-necked Phalaropes.

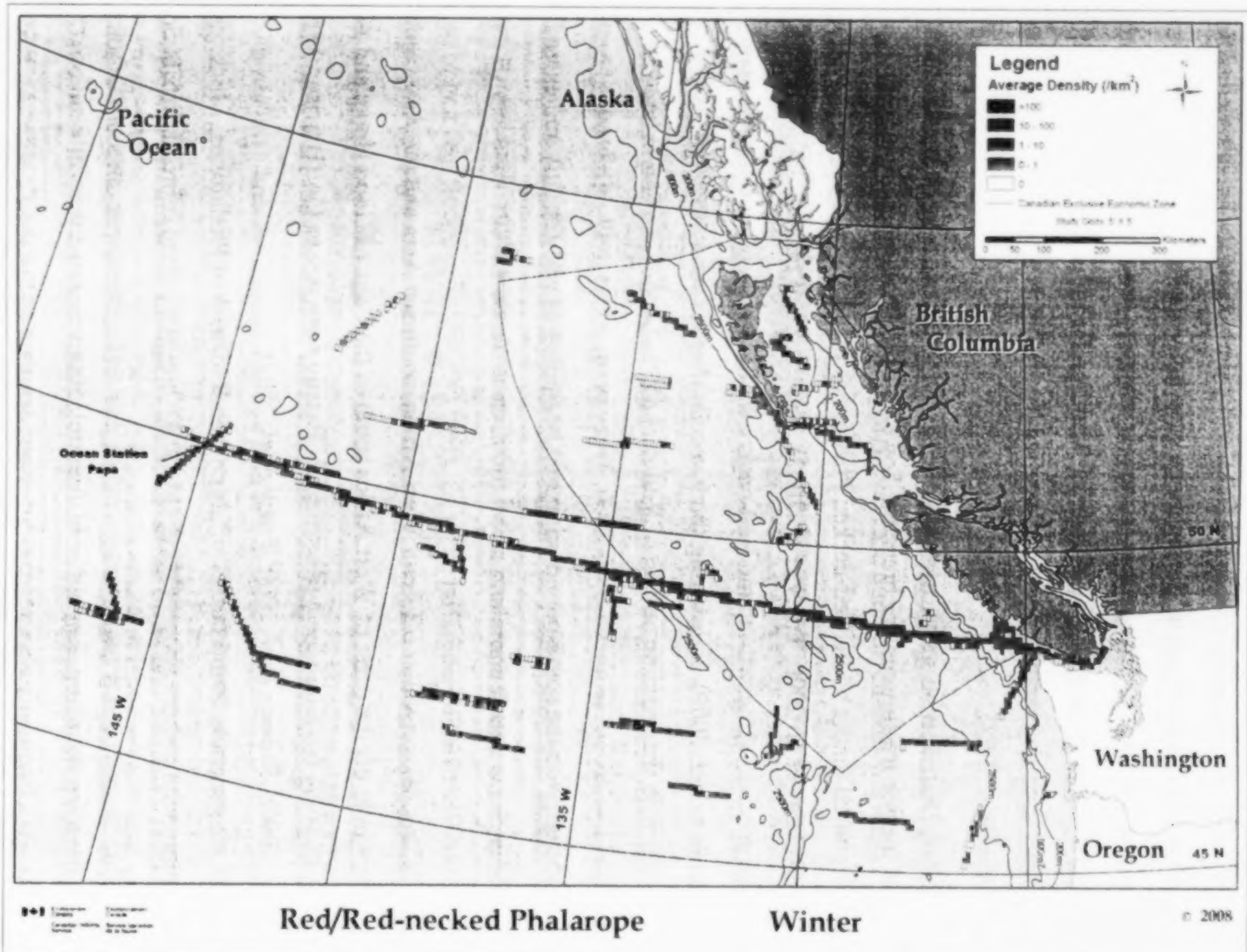

Figure 24D. Seasonal average grid cell densities of Red/Red-necked Phalaropes.

3.1.6.1 Red / Red-necked Phalarope *Phalaropus fulicarius/P. lobatus*

3.1.6.1.1 Population and Conservation Status

Red and Red-necked Phalaropes are very similar looking species when in non-breeding plumage, causing difficulty differentiating the two in the field, particularly in poor observing conditions or when in mixed species flocks. Many of the sightings were noted as Phalarope sp., and thus we have elected to treat the two species together (simply referring to the two species as phalaropes). Both species have large populations: an estimated 1.9 million Red Phalaropes and 3.5 million Red-necked Phalaropes; and both species are classified by the IUCN as species of *Least Concern* (BirdLife International 2008).

3.1.6.1.2 Breeding Distribution and Chronology

Both phalarope species are circumpolar breeders; however, Red Phalaropes are closely associated with coastal tundra while Red-necked Phalaropes breed along the coast as well as further inland (Rubega *et al.* 2000, Tracy *et al.* 2002). The timing of peak migration differs between the two species, with north-bound Red-necked Phalaropes migrating earlier than Red Phalaropes (Rubega *et al.* 2000). Egg-laying (both species) begins soon after their arrival on the breeding grounds, with the breeding season of Red-necked Phalaropes starting in late May and mid-June for Red Phalaropes (Rubega *et al.* 2000, Tracy *et al.* 2002). Fall migration of both species is protracted, with the south-bound migration beginning as early as July and extending through to November.

3.1.6.1.3 Oceanic Distribution and Diet

Red-necked Phalaropes overwinter off Peru, West Africa, southeast Asia and the Arabian Sea. Red Phalaropes winter off the coast of West Africa south to the Cape of Good Hope, and South America to Chile; some remain in the northeastern N Pacific from AK to CA (Harrison 1983, Campbell *et al.* 1990b, Rubega *et al.* 2000, Tracy *et al.* 2002).

Red Phalaropes are generally found farther offshore than Red-necked Phalaropes, which tends to be associated more with inshore waters (Mayfield 1984); however, there is broad distributional overlap. Briggs *et al.* (1987) noted that in CA waters, only Red Phalaropes were likely to be found >50 km from the mainland. Rintoul *et al.* (unpubl. 2006) reported that off southern CA, Red Phalaropes were frequently encountered (over and seaward of the shelf); whereas, Red-necked Phalaropes were rarely observed.

Wahl *et al.* (2005) indicated that Red-necked Phalaropes have been observed in WA between April and November, with peak numbers in May and early August through mid-September. Although Red Phalaropes are considered by Wahl *et al.* (2005) to be less common in WA than Red-necked Phalaropes, they have been recorded there in all months. According to Campbell *et al.* (1990b), Red-necked Phalaropes and Red Phalaropes have been observed in BC between April and November, and April and December, respectively. They reported that the majority of Red-necked Phalarope records were from May (almost 24% of total records) and from July through September (67%); whereas, most Red Phalaropes (80% of all records) were from August through November.

Both phalarope species are strongly associated with convergent fronts where they feed on invertebrates, zooplankton, small squid, larval fish, and polychaetes worms, at or just below the surface of the water (Sanger 1986).

3.1.6.1.4 Spatial Distribution and *Average Grid Cell Density* in Study Area

In spring, phalarope *average grid cell density* was as high as 6.6 birds/km^2, with densities exceeding 1.0 bird/km^2 primarily found along the shelfbreak or over the shelf. However, phalaropes also occurred well offshore, with birds observed near OSP. The first spring records of phalaropes were from early May. Where identified to species, it appears that Red-necked Phalaropes occurred in the study area earlier than Red Phalaropes; this agrees with other reports (e.g., Briggs *et al.* 1987, Rubega *et al.* 2000). Most phalarope flocks were generally small; there were only a few flocks exceeding 30 birds. Of those birds identified to species, Red-necked Phalaropes were observed only over the shelf or shelfbreak, and Red Phalaropes were observed both nearshore and offshore.

Phalaropes were most abundant during summer. The highest *average grid cell density* was 71.0 birds/km^2; however, most *average grid cell densities* were <11.0 birds/km^2. When identified to species, most of the larger flocks were of Red-necked Phalaropes. Areas with higher *average grid cell densities* included Queen Charlotte Strait and Swiftsure Bank; the latter was the location where the largest summer-time gathering (63 birds) was observed. Similar to that noted during spring, Red Phalaropes were seen almost exclusively seaward of the shelfbreak, with notable numbers seen near Cobb Seamount. Red Phalaropes were observed primarily in late August to early September. In contrast, although low numbers of Red-necked Phalaropes were seen in September, most were observed earlier in the summer, especially in mid-August.

Few phalaropes were observed during fall. Highest *average grid cell densities* occurred well offshore west, northwest of Vancouver Island (at 140°W), as well as in Juan de Fuca Strait. Although many sightings were noted simply as phalarope species, there were no fall records of Red-necked Phalaropes.

Even fewer phalaropes were seen during winter. Birds were encountered only along Line P (between approximately 128.5° W and 130.5° W) and only during February and March.

3.1.7 Skuas and Jaegers

South Polar Skua (*Stercorarius maccormicki*).
© Louise K. Blight.

Jaegers and skuas, superficially similar to gulls, are well known for their habit of stealing prey from other species (i.e., kleptoparasitism). For species of birds that rely upon this type of foraging method, their distribution may reflect that of the species they most often parasitize. It is generally thought that there are two groups of skuas - the great skuas which are large, heavy, brown birds with several (up to five species) breeding in the S Hemisphere and one in the N Hemisphere; and the three N Hemisphere nesting jaegers, which are smaller and lighter birds, often with patterned/barred plumage and during breeding season, with long tail feathers. Some authors place the great skuas in the genus *Catharacta* and the jaegers in the genus *Stercorarius* while others put them all in the *Stercorarius* genus (Cohen *et al.* 1997, Braun and Brumfield 1998). We have followed the latter approach, with skuas and jaegers all being placed in the *Stercorarius* genus.

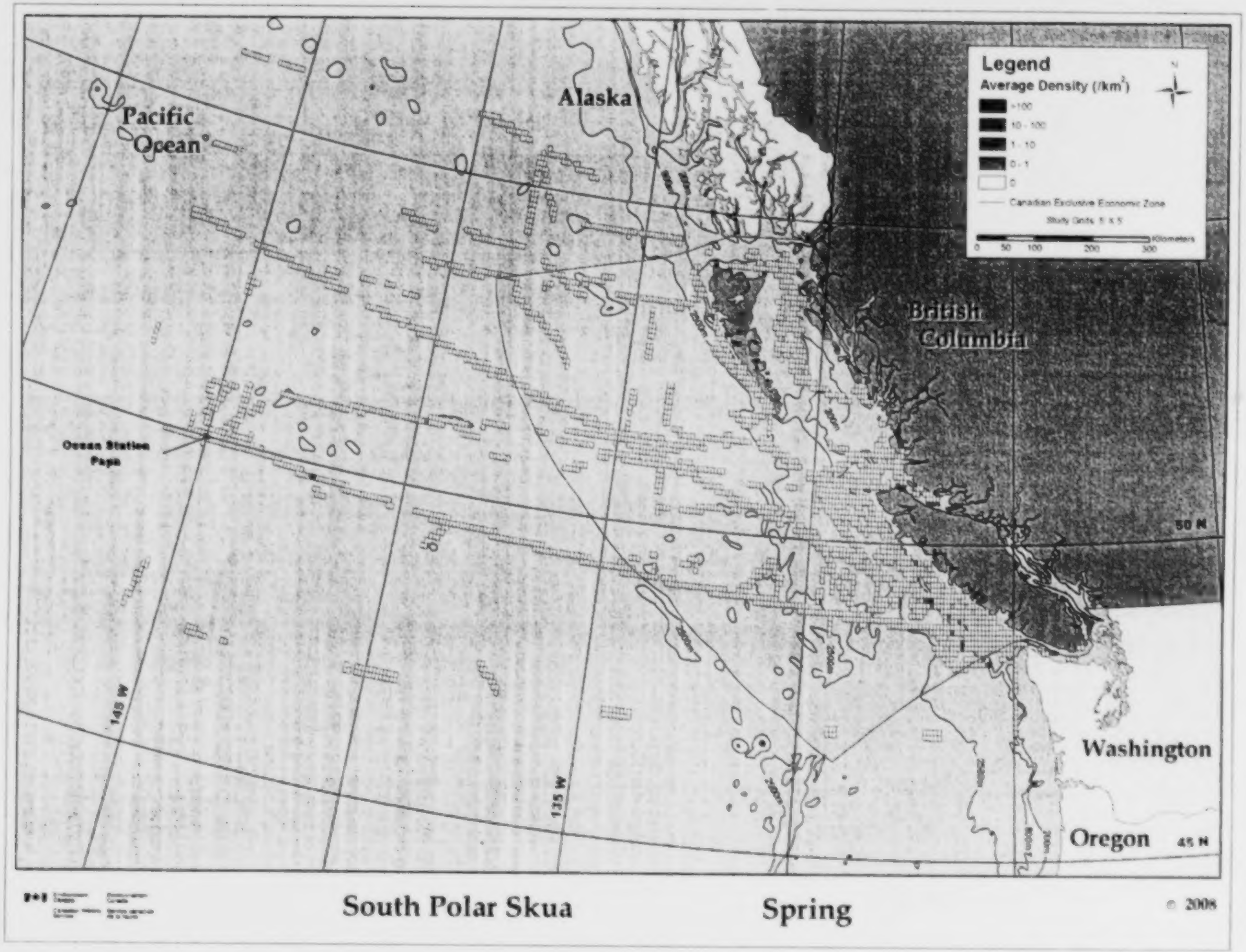

Figure 25A. Seasonal average grid cell densities of South Polar Skuas.

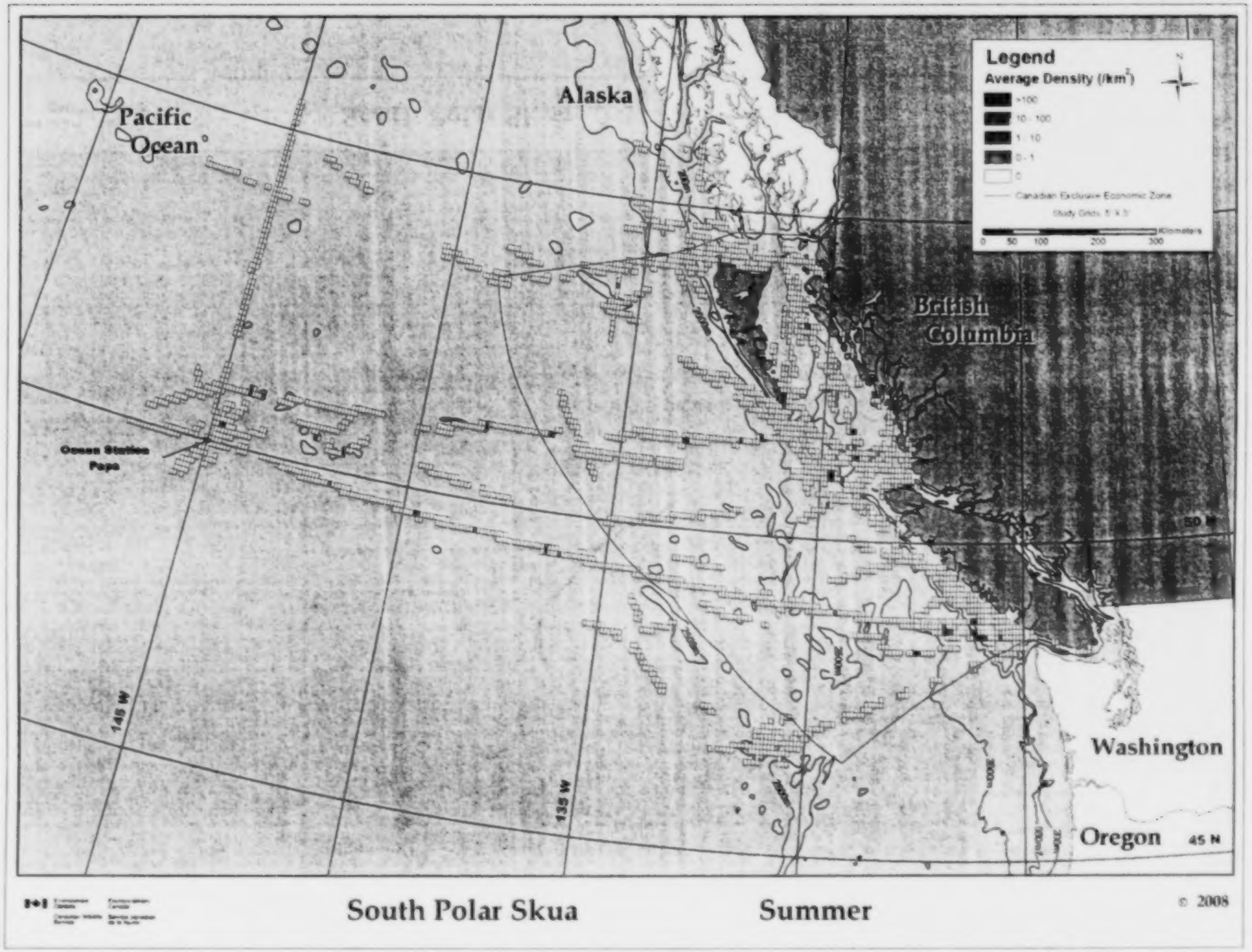

Figure 25B. Seasonal average grid cell densities of South Polar Skuas.

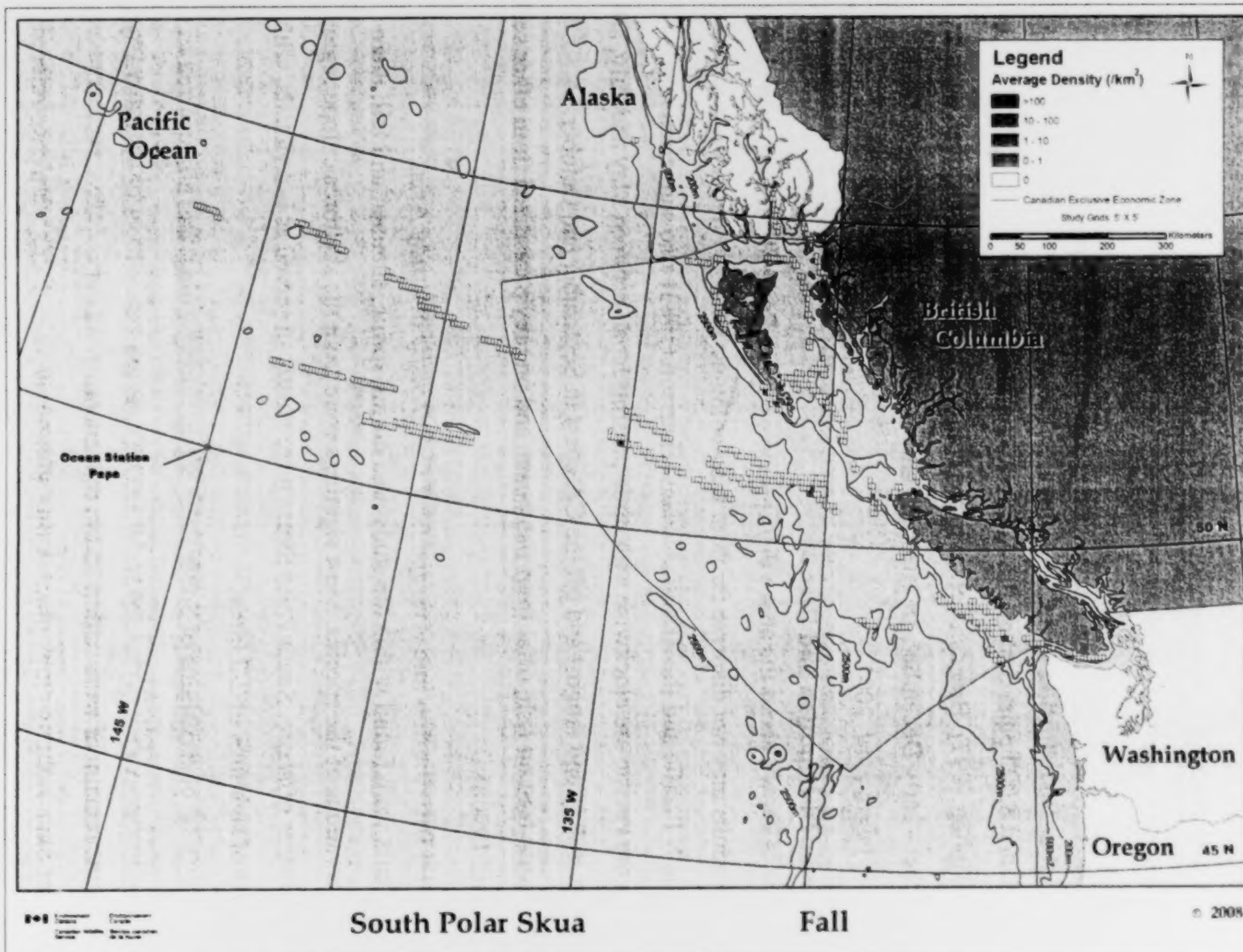

Figure 25C. Seasonal average grid cell densities of South Polar Skuas.

3.1.7.1 South Polar Skua *Stercorarius maccormicki*

3.1.7.1.1 Population and Conservation Status

Although the global population of South Polar Skuas is estimated at 20,000 birds, the population is thought to be stable and is therefore considered by the IUCN to be a species of *Least Concern* (BirdLife International 2008). However, Kushlan *et al*. (2002) and Milko *et al.* (2003) list the South Polar Skua as a species of *Moderate Conservation Concern* for N America and Canada, respectively.

3.1.7.1.2 Breeding Distribution and Chronology

Between 5,000 and 8,000 pairs nest on the Antarctic continent and the South Shetland Islands (Enticott and Tipling 1997). Breeders return to the colonies in September/October, eggs are laid in late November - early December, and fledging and dispersal starts in February/March (Harrison 1983, Pezzo *et al.* 2001)

3.1.7.1.3 Oceanic Distribution and Diet

Relatively little is known about the at-sea distribution of South Polar Skuas. Harrison (1983) suggested that adults may not disperse far from their colonies; whereas juveniles routinely migrate into the N Pacific and the Atlantic Oceans. Harrison (1983) also suggested that movements in the Pacific are clockwise with birds passing Japan between May and July, arriving in BC and WA in July and August and off the CA coast in September and October.

South Polar Skuas feed on fish, offal from fish boats, and on prey parasitized from other seabirds (Campbell *et al.* 1990b).

3.1.7.1.4 Spatial Distribution and *Average Grid Cell Density* in Study Area

South Polar Skuas were found within the study area during spring, summer, and fall; there were no winter observations of the species. Most sightings were from the shelfbreak/slope region as well as from further offshore. South Polar Skuas were mostly observed as individuals, with a limited number of sightings of 2-3 birds.

There were only nine observations of South Polar Skuas during spring; and all occurred in the first two weeks of June (earliest on 1 June). Of the nine spring sightings of Skuas, only two were well offshore; the remainder were within 75 km of Vancouver Island.

The majority of Skua sightings took place during summer months. Birds were encountered at low *average grid cell densities* throughout much of the study area; from <25 km away from Banks Island to west of OSP. The highest *average grid cell densities* were located over Goose Island Bank (Queen Charlotte Sound) and at the edge of Campbell Seamount.

The latest we encountered a South Polar Skua was on 5 October; previously, Morgan *et al.* (1991) reported seeing the last one of the year on 15 October. At this time of the year, Skuas were encountered primarily over the shelf or along the shelfbreak. Birds were seen from as close as 4 km to approximately 300 km away from the nearest land. Although Skuas appear to vacate the study area between October and February, the low survey effort prevents us from stating that they are completely absent during those months.

South Polar Skuas have been reported in BC between 13 June and 22 November (Campbell *et al.* 1990b); and, in WA from 14 May to 7 October (Wahl *et al.* 2005).

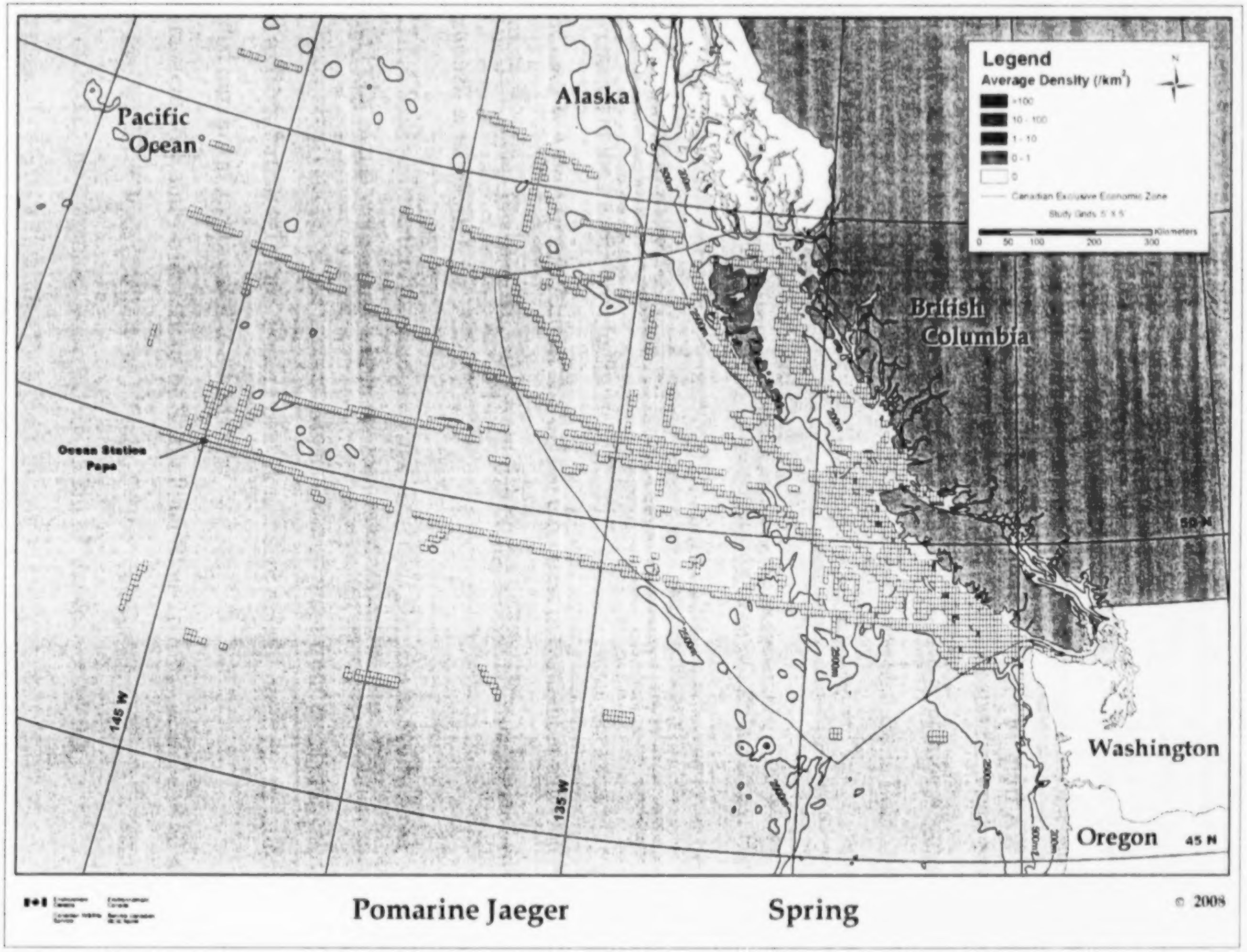

Figure 26A. Seasonal average grid cell densities of Pomarine Jaegers.

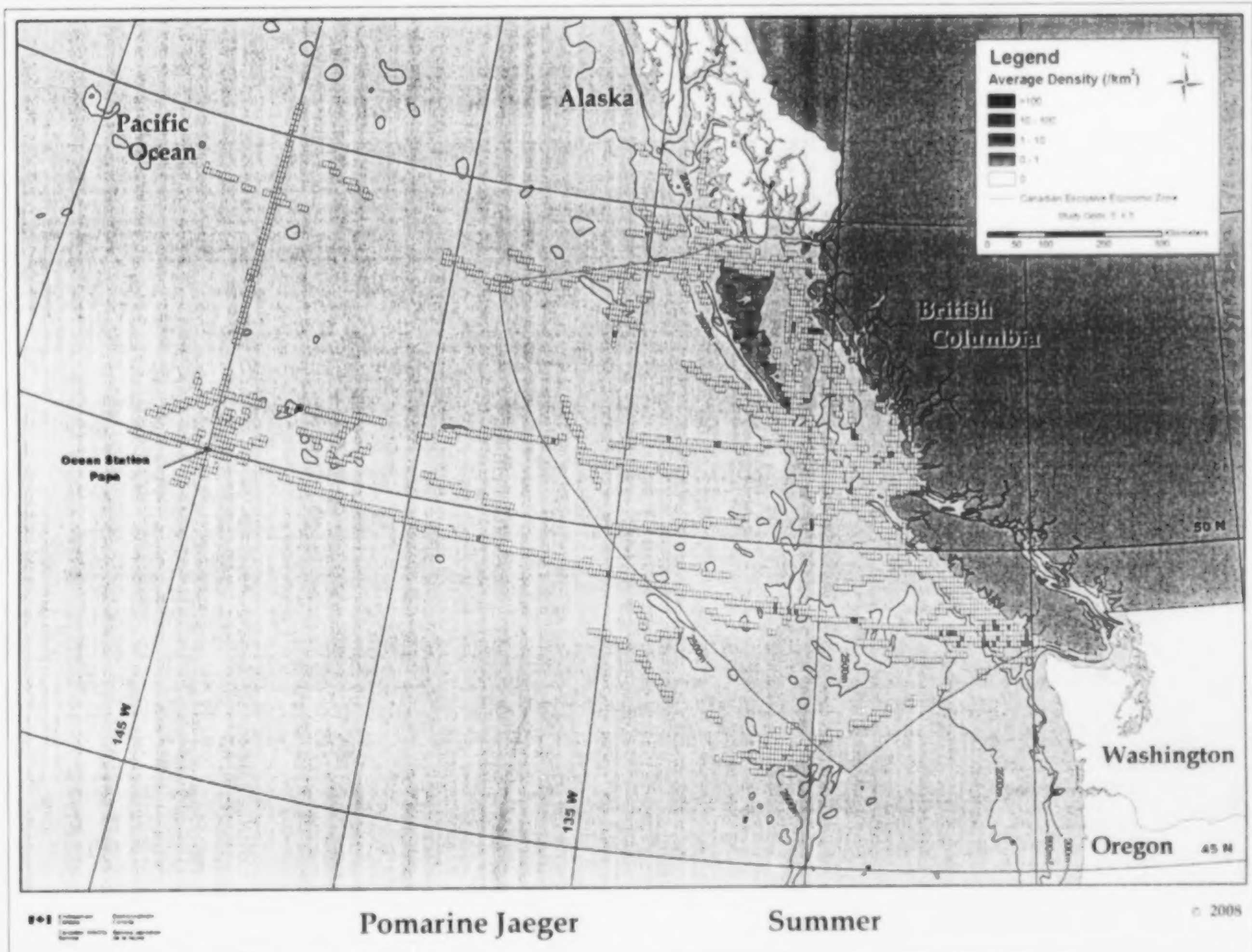

Figure 26B. Seasonal average grid cell densities of Pomarine Jaegers.

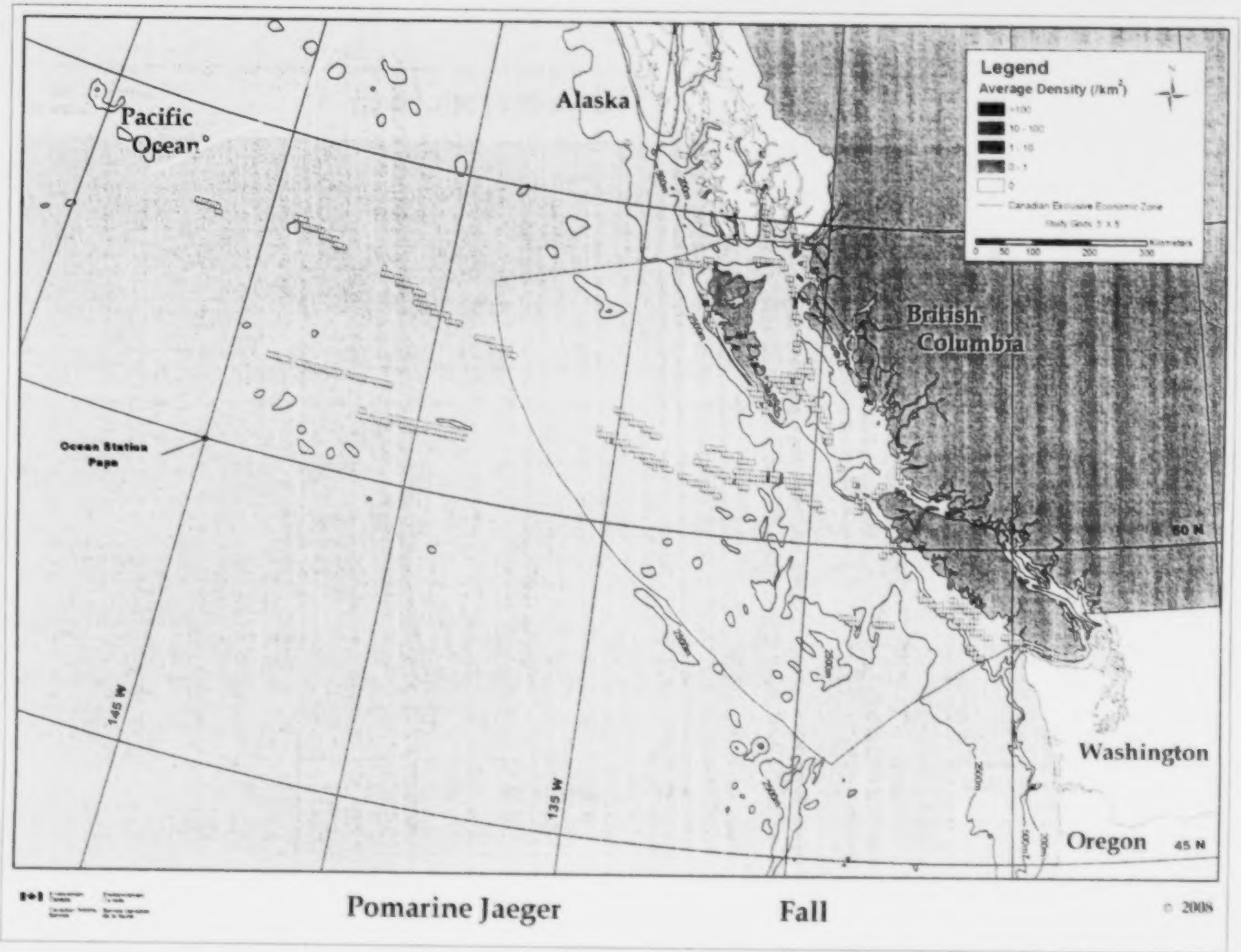

Figure 26C. Seasonal average grid cell densities of Pomarine Jaegers.

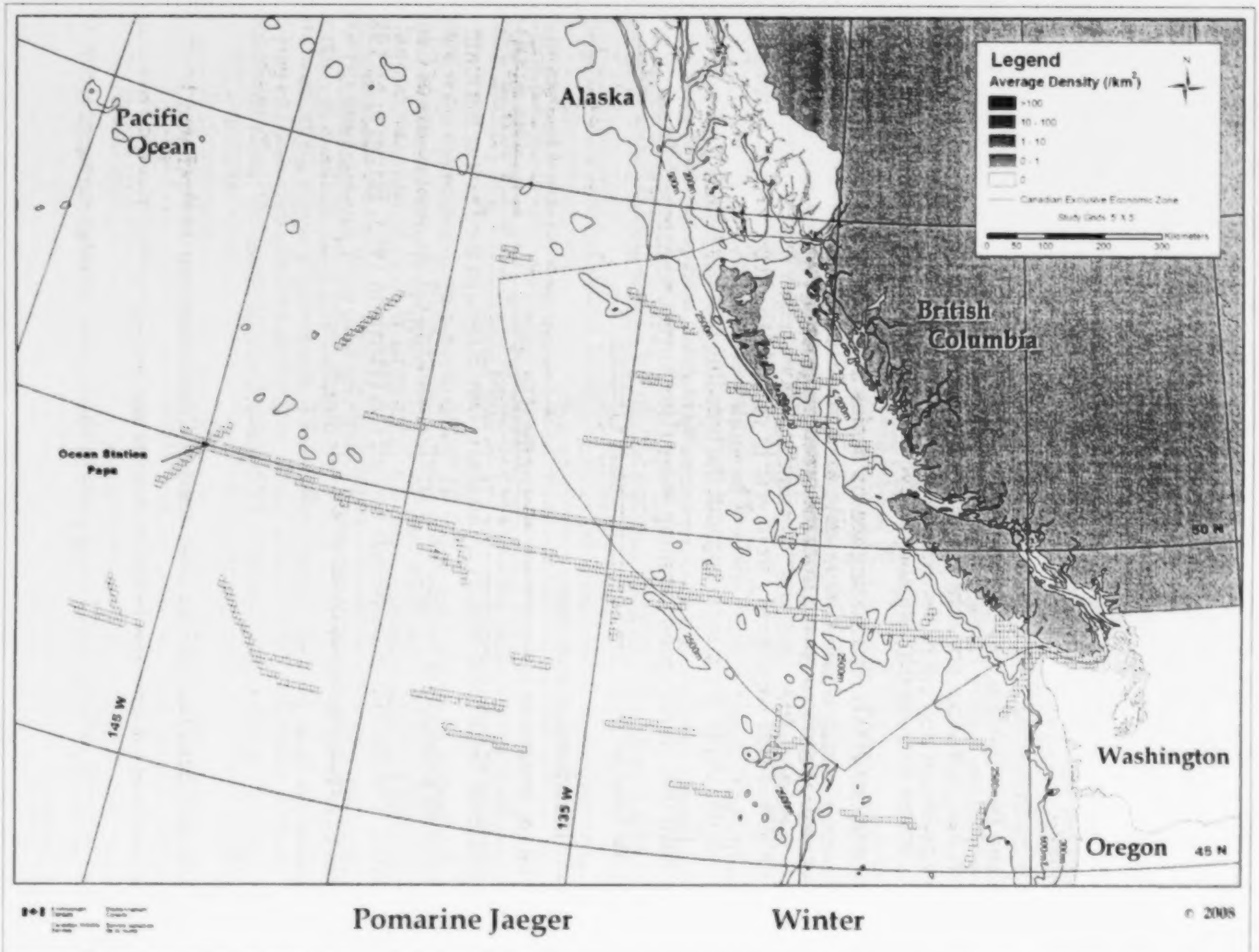

Figure 26D. Seasonal average grid cell densities of Pomarine Jaegers.

3.1.7.2 Pomarine Jaeger *Stercorarius pomarinus*

3.1.7.2.1 Population and Conservation Status

The Pomarine Jaeger is the largest of the three jaeger species; and of the three species, the Pomarine Jaeger may have the smallest global population (estimated at 100,000 birds). However, the populations are believed to be stable, and therefore the species is considered to be of *Least Concern* by the IUCN (BirdLife International 2008). Kushlan *et al.* (2002) and Milko *et al.* (2003) list the Pomarine Jaeger as a species of *Low Conservation Concern* for N America and Canada, respectively.

3.1.7.2.2 Breeding Distribution and Chronology

Pomarine Jaegers nest in Russia, northern AK to north-central Arctic Canada and in Greenland (Harrison 1983), where they are dependant upon cyclical populations of lemmings for successful breeding (Wiley and Lee 2000). The nesting season begins in mid-May and lasts until mid-August when the birds begin to disperse from the breeding grounds (Wiley and Lee 2000). Pomarine Jaegers do not nest consistently from year to year; during years with low lemming numbers, many adults simply disperse throughout the breeding grounds before heading south earlier (July/August) than during good lemming years (late August/September). In successful years, the juveniles head south in late September/early October.

3.1.7.2.3 Oceanic Distribution and Diet

In the northern GOA, Pomarine Jaegers were encountered in spring (May and rarely April) and fall (October), and most birds were seen over the shelf (Day 2006). In the Pacific, the main wintering areas are off southeast Australia, with smaller numbers off the west coasts of Central and South America, near the Hawaiian Islands and off CA (Harrison 1983, Briggs *et al.* 1987). Pomarine Jaegers have been encountered in WA in all months, with peak numbers in August to October, and a smaller, secondary peak during spring migration, (mainly mid-April to early June, Wahl *et al.* 2005).

Pomarine Jaegers have been seen off the west coast of Canada between 24 April and 1 December, with >68% of all sightings between August and the end of October. The BC spring migration occurs between late April and early June, with the main passage taking place in May (Campbell *et al.* 1990b).

Pomarine Jaegers feed on fish (e.g., Pacific sandlance, capelin [Sanger 1986]), stolen from a wide variety of species (including shearwaters, gulls, kittiwakes, terns and alcids), and offal discarded from ships (Wiley and Lee 2000); they will also eat carrion (Harrison 1983).

3.1.7.2.4 Spatial Distribution and *Average Grid Cell Density* in Study Area

Pomarine Jaegers were most often seen in the study area during summer; there were scattered encounters during spring and fall, and only a single winter observation.

During spring, Pomarine Jaegers were recorded at low *average grid cell densities* (<0.6 birds/km^2) and were seen only 12 times within the study area. All encounters were from either the west coast of Vancouver Island or the northwest coast of WA, primarily over the shelf or the shelfbreak. The majority of spring observations occurred in the first two weeks of May; the remainder were in early June.

Summer densities of Pomarine Jaegers were only slightly higher than observed during spring; the highest *average grid cell density* was just under 1.0 bird/km^2. Although birds were seen throughout the summer, most observations of Pomarine Jaegers were from mid-August to mid-September. As during spring, many sightings were over the continental shelf, southwest of Vancouver Island. Compared to spring, the summer records were more widely distributed, including well offshore (almost to 143.5° W). Pomarine Jaegers were seen over Bowie, Pathfinder and Explorer Seamounts.

There were very few fall transects south of 50° N; and perhaps as a result of this, Pomarine Jaegers were encountered only north of 50° N. Birds were observed over the shelf as well as offshore to just west of 135° W (maximum distance approximately 265 km from the nearest land). All fall sightings were of single individuals, and the latest observation was 5 October.

There was only a single observation of Pomarine Jaeger during winter; on 9 February, a bird was encountered along the slope approximately 85 km west of Cape Beale.

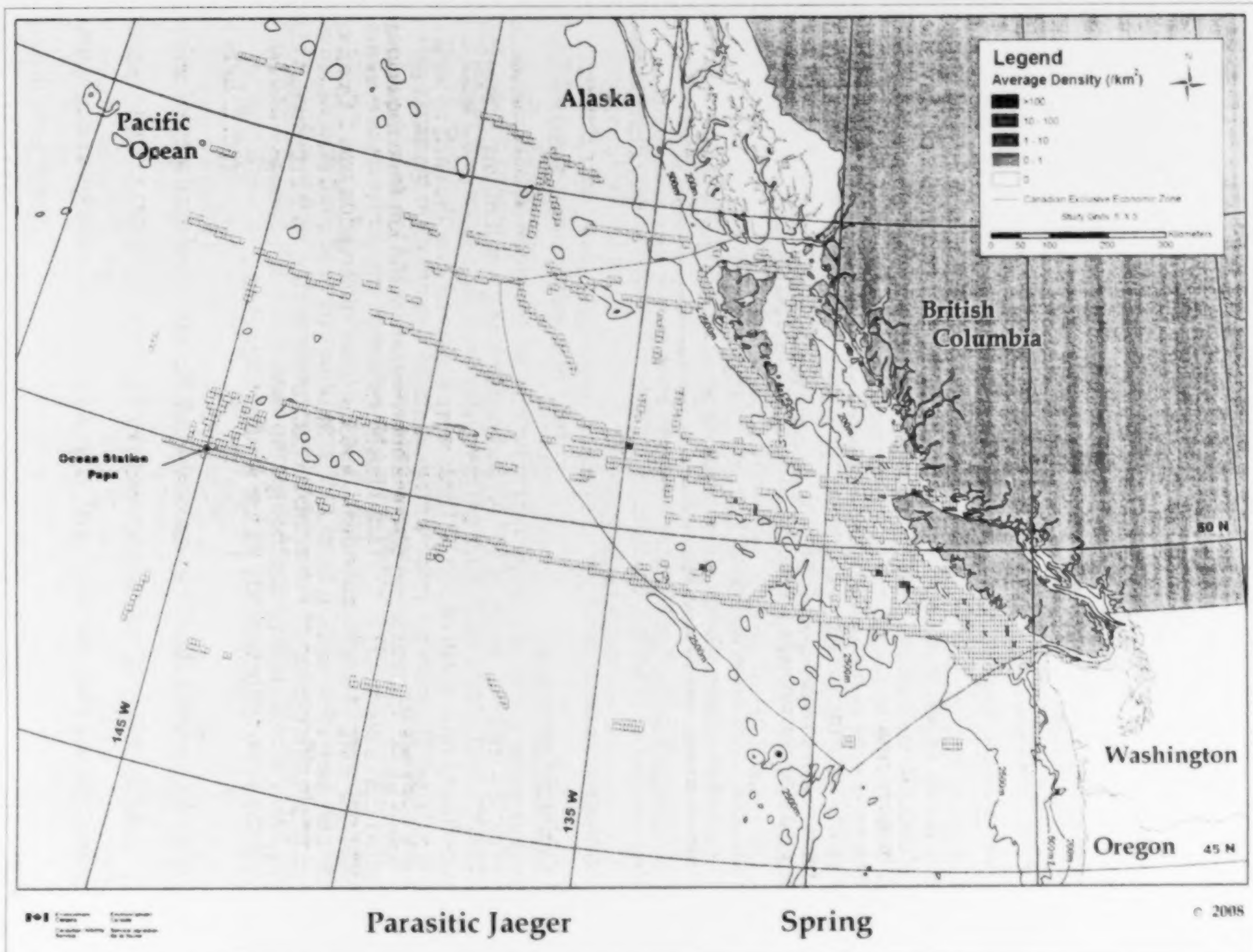

Figure 27A. Seasonal average grid cell densities of Parasitic Jaegers.

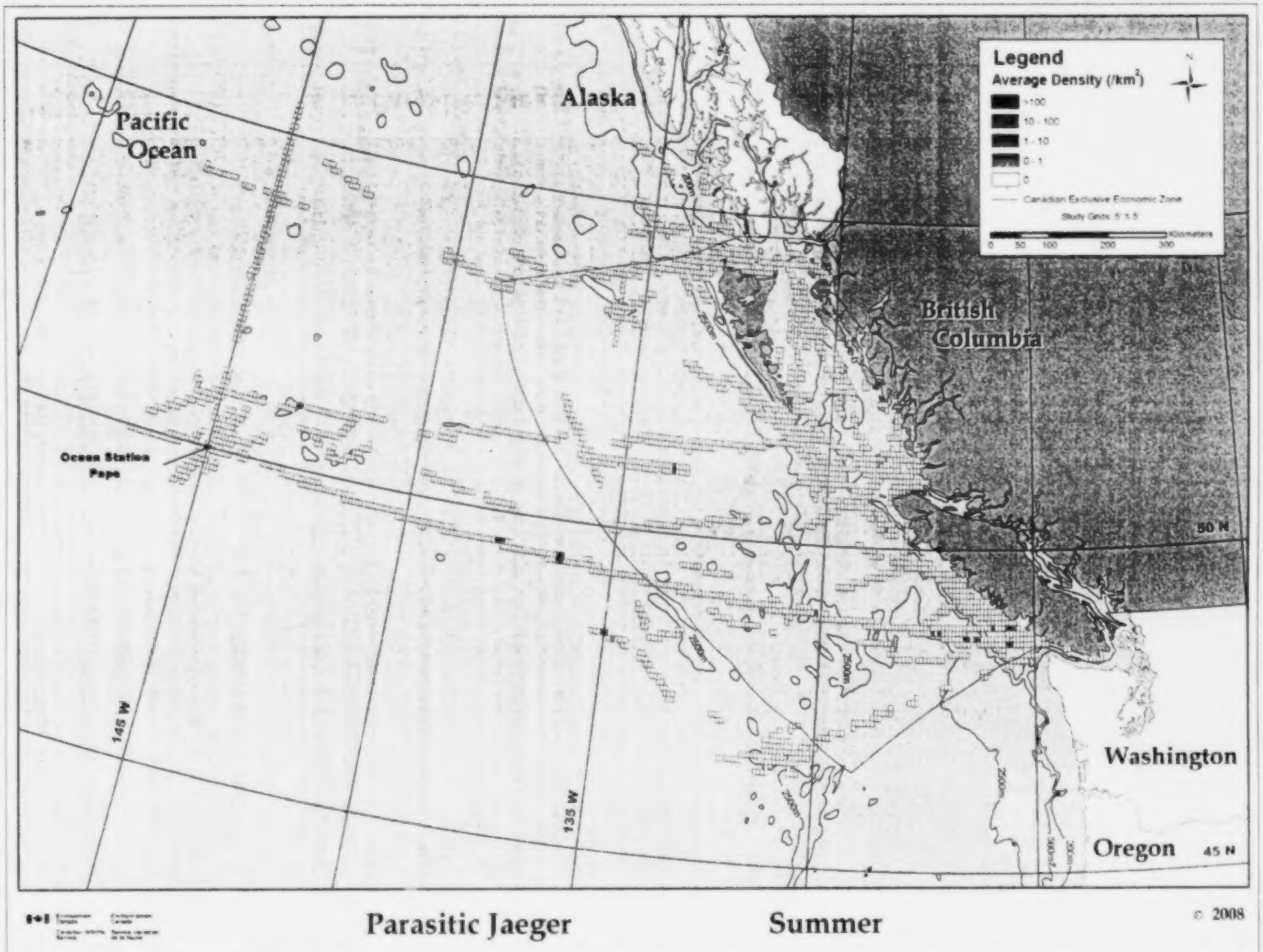

Figure 27B. Seasonal average grid cell densities of Parasitic Jaegers.

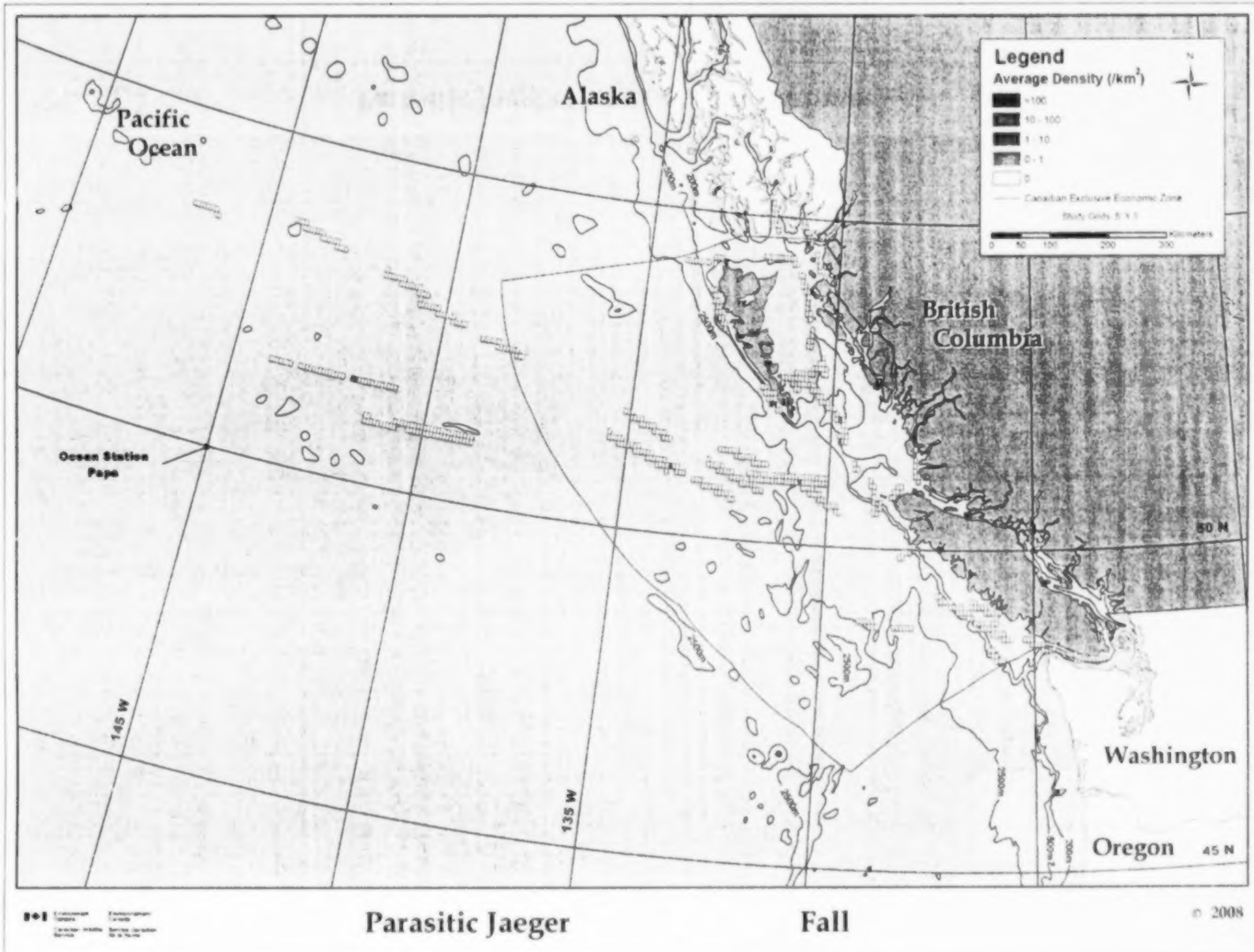

Figure 27C. Seasonal average grid cell densities of Parasitic Jaegers.

3.1.7.3 Parasitic Jaeger *Stercorarius parasiticus*

3.1.7.3.1 Population and Conservation Status

The global population of Parasitic Jaegers has been estimated as high as 1,000,000 birds. As a consequence, the species is listed as a species of *Least Concern* by the IUCN (BirdLife International 2008), and as a species of *Low Conservation Concern* for N America and Canada (Kushlan *et al.* (2002) and Milko *et al.* (2003), respectively).

3.1.7.3.2 Breeding Distribution and Chronology

Parasitic Jaegers are circumpolar in Arctic regions, breeding generally further south than the other two jaeger species. They nest from western AK and the Aleutians east along northern Canada to Hudson Bay and Labrador, on Greenland, Iceland, islands off Scotland, Sweden, Norway, Finland and the coasts of Russia to the Kamchatka Peninsula (Harrison 1983, Wiley and Lee 1999). Breeders return to their nesting areas in late April - early May, while non-breeders and immatures generally arrive later. Eggs are laid in May/June, departure of non-breeders starts in July, and fledging and dispersal takes place in late August - early September (Maher 1974, Harrison 1983, Wiley and Lee 1999). The timing of the migration of Parasitic Jaegers is believed to coincide with the migration of the main victims of their kleptoparasitic habit - Arctic Terns (*Sterna paradisaea*), Sabine's Gulls (*Xema sabini*) and Black-legged Kittiwakes (*Rissa tridactyla*) (Furness 1983, Wiley and Lee 1999).

3.1.7.3.3 Oceanic Distribution and Diet

The exact wintering areas of Parasitic Jaegers are not known, but are believed to be in the Pacific and Atlantic Oceans between 30° and 50° S (Harrison 1983, Wiley and Lee 1999). Briggs *et al.* (1987) observed Parasitic Jaegers mainly within 15 km of the coast of CA, and none beyond 75 km from land. In contrast, Wahl *et al.* (1989) observed migrant Parasitic Jaegers across the entire N Pacific.

Day (2006) considered the Parasitic Jaeger to be rare in the GOA in spring and fall, on the shelf and offshore. Most sightings in WA have occurred in May and from July through October (Wahl *et al.* 2005).

At sea, this species relies almost entirely upon stealing fish (e.g., capelin, Pacific sandlance) and other materials disgorged by other seabirds (Harrison 1983, Livingston 2001).

3.1.7.3.4 Spatial Distribution and *Average Grid Cell Density* in Study Area

Parasitic Jaegers were seen in the study area from <15 km to > 765 km from land. This species was rarely encountered during spring; the earliest observations were on 4 April 2005 about 17 km south of Estevan Point, and on 5 April 2005 in Hecate Strait. Most other spring observations occurred in late May or early June except for a sighting of three birds just east of OSP on 9 May 1982. The highest spring *average grid cell density* occurred over Union Seamount.

Parasitic Jaegers occurred throughout summer months with no bias towards any particular time period. They were observed over the shelf and well offshore, including over Pathfinder Seamount; however none were seen north of 51° N.

During fall, there were only five observations of Parasitic Jaegers; all of single birds. Two of the sightings were at the shelfbreak/slope region with one bird found near the edge of Goose Island Band and the other approximately 10 km west of the Moresby Island. The remaining three were observed well offshore. All fall sightings occurred from mid-September to the first week of October.

We did not observe Parasitic Jaegers within the study area during winter. However, Campbell *et al.* (1990b) reported that they have been seen in BC between 27 April and 2 December, plus an apparent sighting on 2 January. They also stated that some Parasitic Jaegers overwinter off southern CA and Maine (MA); however, Harrison (1983) cautioned that some mid-winter sightings of Parasitic Jaegers may be incorrectly identified Pomarine Jaegers.

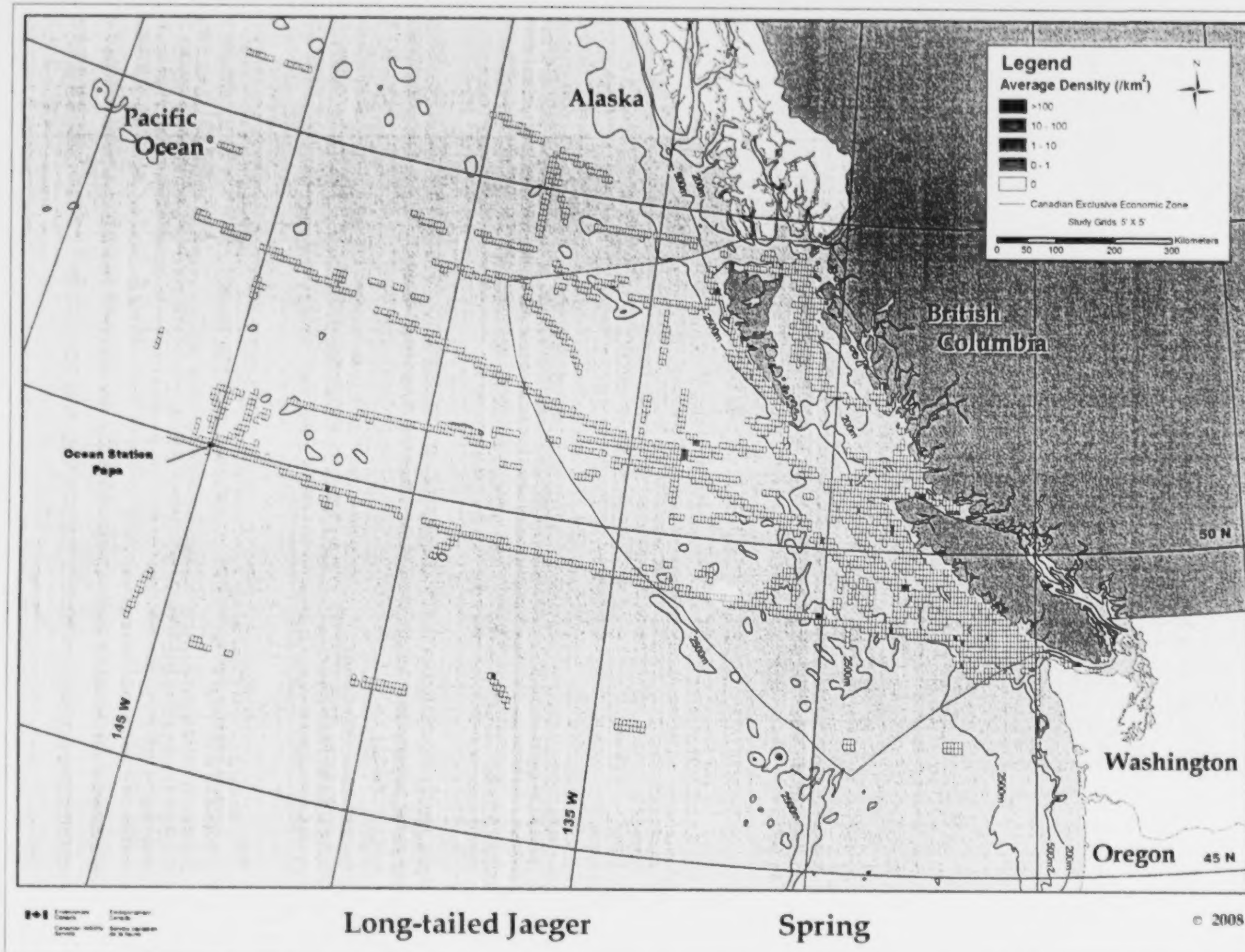

Figure 28A. Seasonal average grid cell densities of Long-tailed Jaegers.

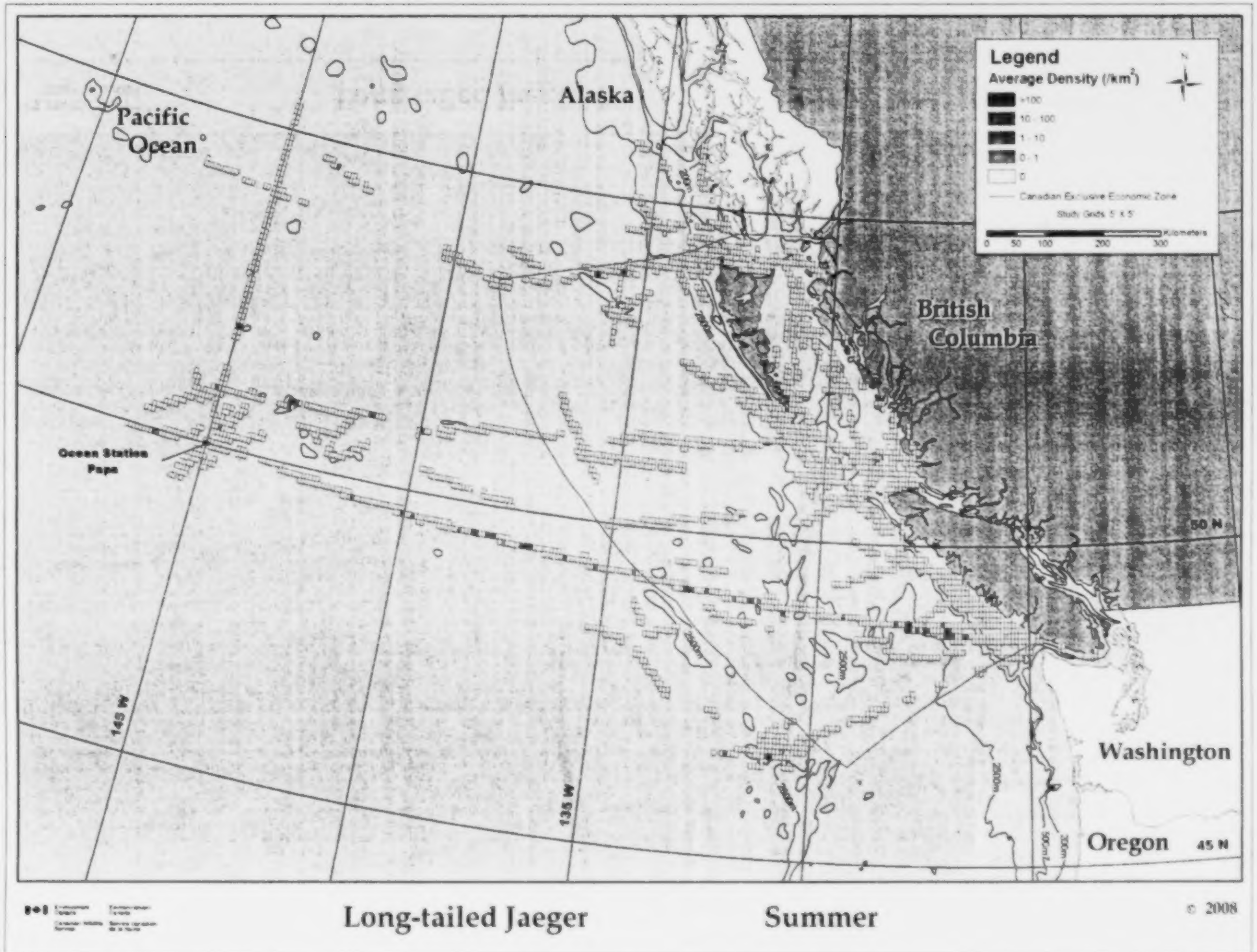

Figure 28B. Seasonal average grid cell densities of Long-tailed Jaegers.

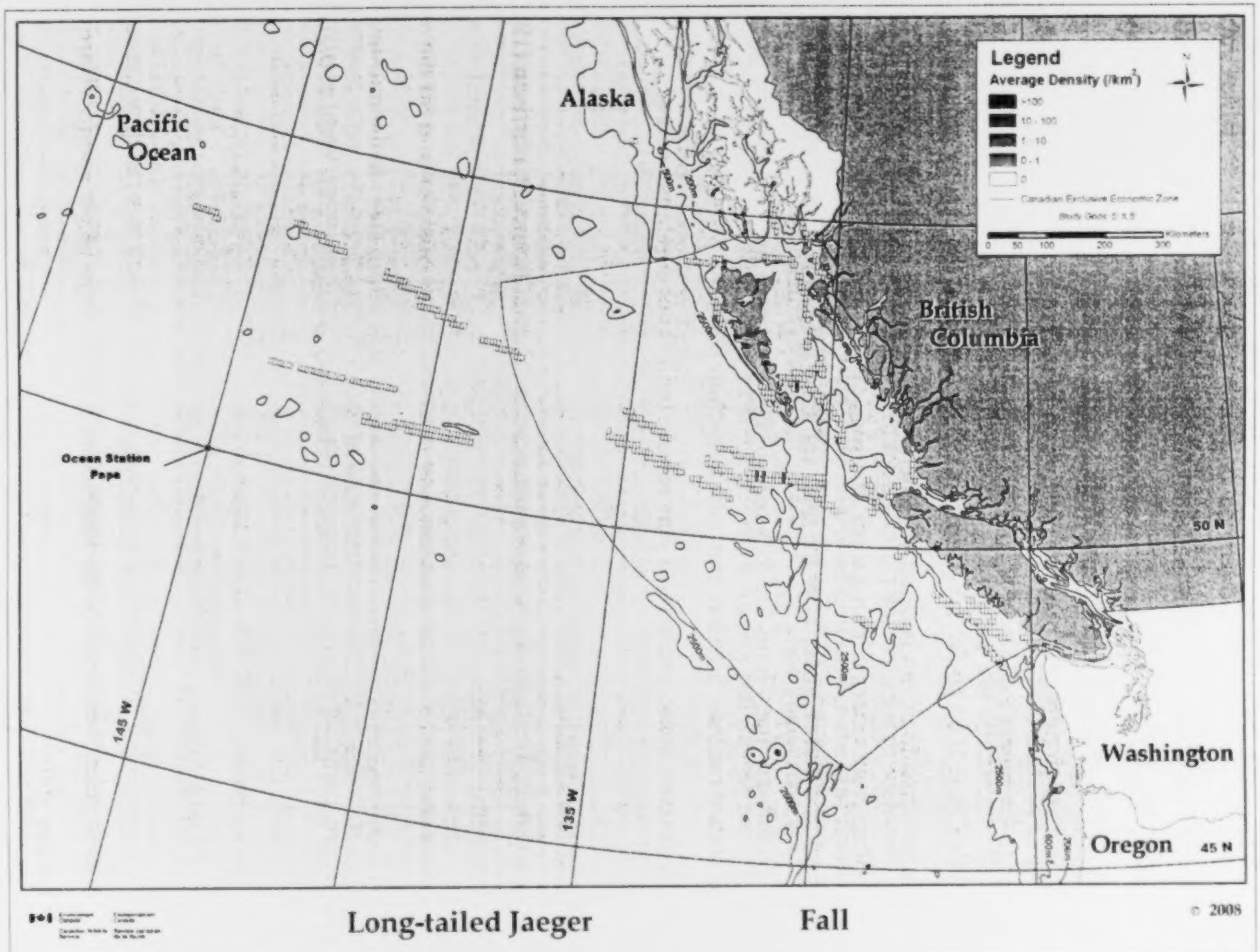

Figure 28C. Seasonal average grid cell densities of Long-tailed Jaegers.

3.1.7.4 Long-tailed Jaeger *Stercorarius longicaudus*

3.1.7.4.1 Population and Conservation Status

The Long-tailed Jaeger with a global population of about 500,000 individuals is considered by the IUCN to be a species of *Least Concern* (BirdLife International 2008). Kushlan *et al.* (2002) and Milko *et al.* (2003) list the Long-tailed Jaeger as a species of *Low Conservation Concern* for N America and Canada, respectively.

3.1.7.4.2 Breeding Distribution and Chronology

Long-tailed Jaegers are circumpolar breeders, nesting on islands in the Arctic Ocean, along the coasts and south to the tundra regions of N America, Greenland and much of Eurasia, primarily north of the Arctic Circle (i.e., 66.56° N) (Harrison 1983). Arrival at the nesting grounds is dependant on snow conditions, but generally breeders start appearing in late May or early June, and egg-laying often commences within a week of arrival (Wiley and Lee 1998). Non-breeders, including apparent immatures, arrive after the main influx of breeders (Harrison 1983). In years of low lemming numbers, many birds fail to breed and dispersal may start as early as mid-June. In years with abundant rodents, breeders and most fledglings leave the breeding grounds beginning in late August; some young birds may remain until October (Harrison 1983, Wiley and Lee 1998).

3.1.7.4.3 Oceanic Distribution and Diet

Little is known about the winter distribution of Long-tailed Jaegers. However, Harrison (1983) suggested that they likely disperse widely in both the Atlantic and Pacific Oceans south to about 50° S and probably concentrate off the east and west coasts of South America, and off the coasts of Namibia and South Africa. They have been observed near upwelling areas in the mid-latitudes of the S Hemisphere, particularly in the Atlantic Ocean (Wiley and Lee 1998). Wahl *et al.* (2005) considered the Long-tailed Jaegers to be the most oceanic of the jaeger species; and their distribution in the northeastern Pacific may in part be determined by the location of concentrations of fishing vessels (Morgan *et al.* 1991).

At sea, Long-tailed Jaegers feed on small fish, carrion and offal, as well as what they can steal from terns and small gulls. They may be the least piratical of the three jaeger species (Harrison 1983, Wiley and Lee 1998).

3.1.7.4.4 Spatial Distribution and *Average Grid Cell Density* in Study Area

Within the study area, the Long-tailed Jaeger was an offshore species with only one bird recorded over the continental shelf (in early October) northeast of Anthony Island.

During spring, Long-tailed Jaegers were encountered both nearshore (along the slope) and offshore. All observations were of individual birds or pairs. The earliest sighting of a Long-tailed Jaeger occurred on 7 May 2000; other observations were spread across the season.

Summer sightings of Long-tailed Jaegers occurred primarily between the third-week of August and into mid-September, although low numbers were encountered from late June to early August. The largest flock at any time of the year (12 birds); was observed >750 km west of Nootka Sound on 29 July 1991.

Long-tailed Jaegers were extremely rare during fall. The species was seen only once, on 5 October 1996, in Hecate Strait. There were no winter sightings in the study area.

According to Campbell *et al.* (1990b) Long-tailed Jaegers have been reported in BC between 11 May and 8 November, with >75% of their records in August and September.

3.1.8 Gulls, Kittiwakes and Terns

Sabine's Gull (*Xema sabini*).
© Carsten Egevang / ARC-PIC.COM.

A total of nine species of gulls (Bonaparte's, Mew, California, Herring, Thayer's, Western, Glaucous-winged, Glaucous and Sabine's), a kittiwake (Black-legged), and a tern (Arctic) were routinely encountered within the study area. An additional three unconfirmed/hypothetical rare

species (Iceland and Slaty-backed Gulls and Aleutian Tern) were also reported; details on these species are presented in section 3.4.

Many gull species have similar plumage, making some species difficult to identify at-sea, especially immature birds in mixed-species flocks. As a result, many gulls were tallied as unidentified gull species, and consequently, the *average grid cell densities* for some of the species may underestimate actual numbers present. Many of the gull species were restricted almost entirely to coastal and shelf waters, while others (kittiwakes and terns especially), occurred over much of the entire study area.

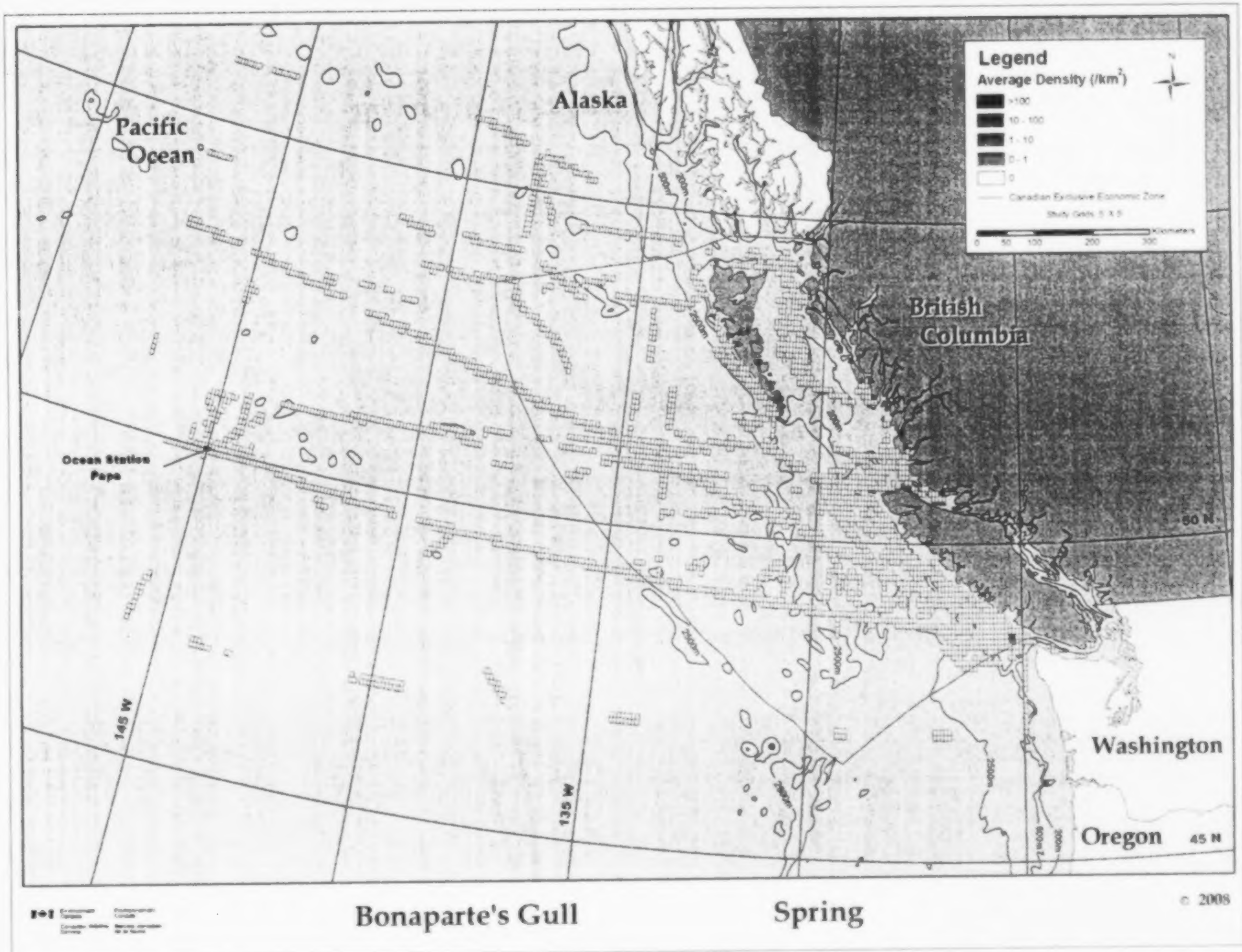

Figure 29A. Seasonal average grid cell densities of Bonaparte's Gulls.

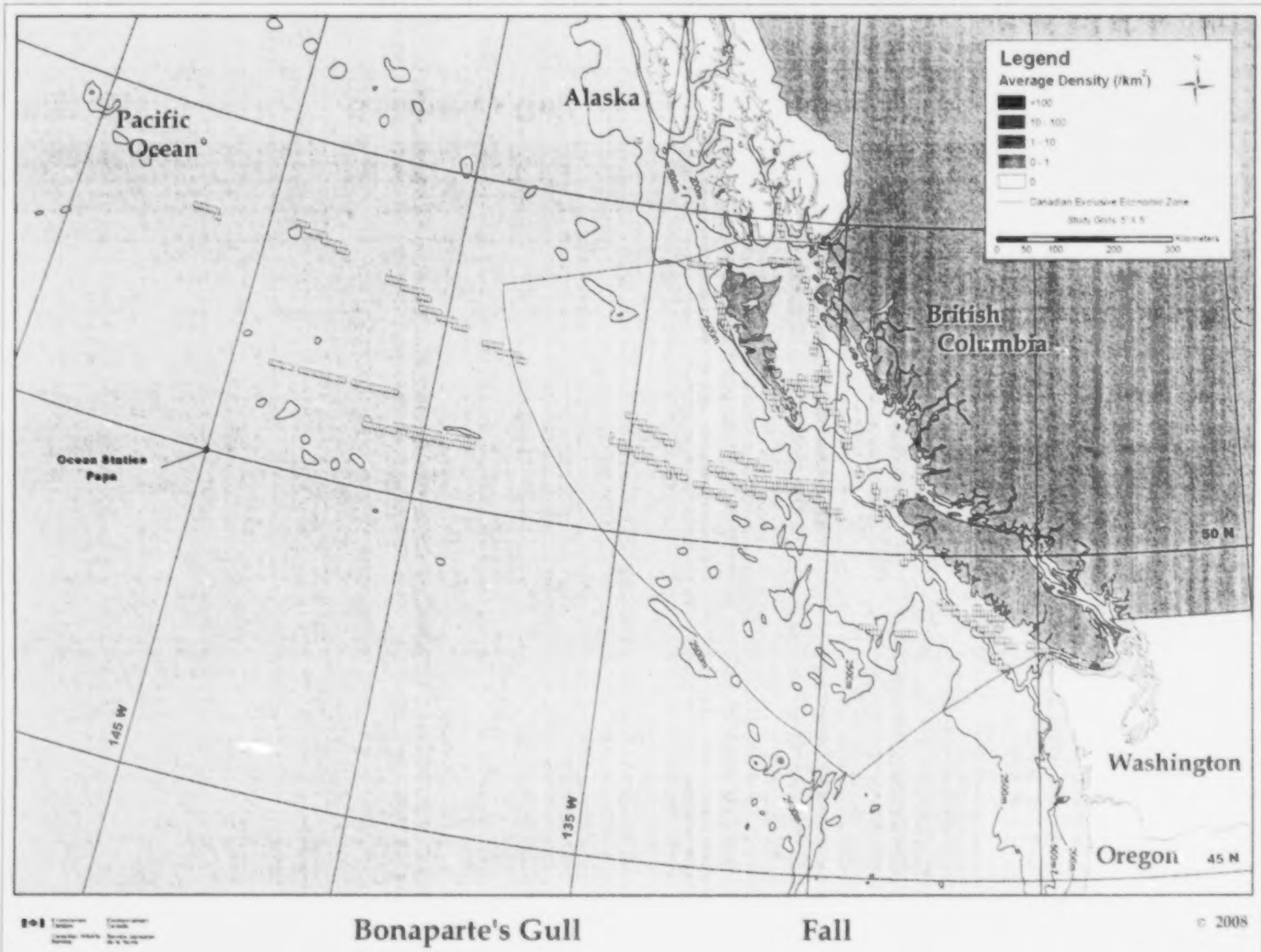

Figure 29B. Seasonal average grid cell densities of Bonaparte's Gulls.

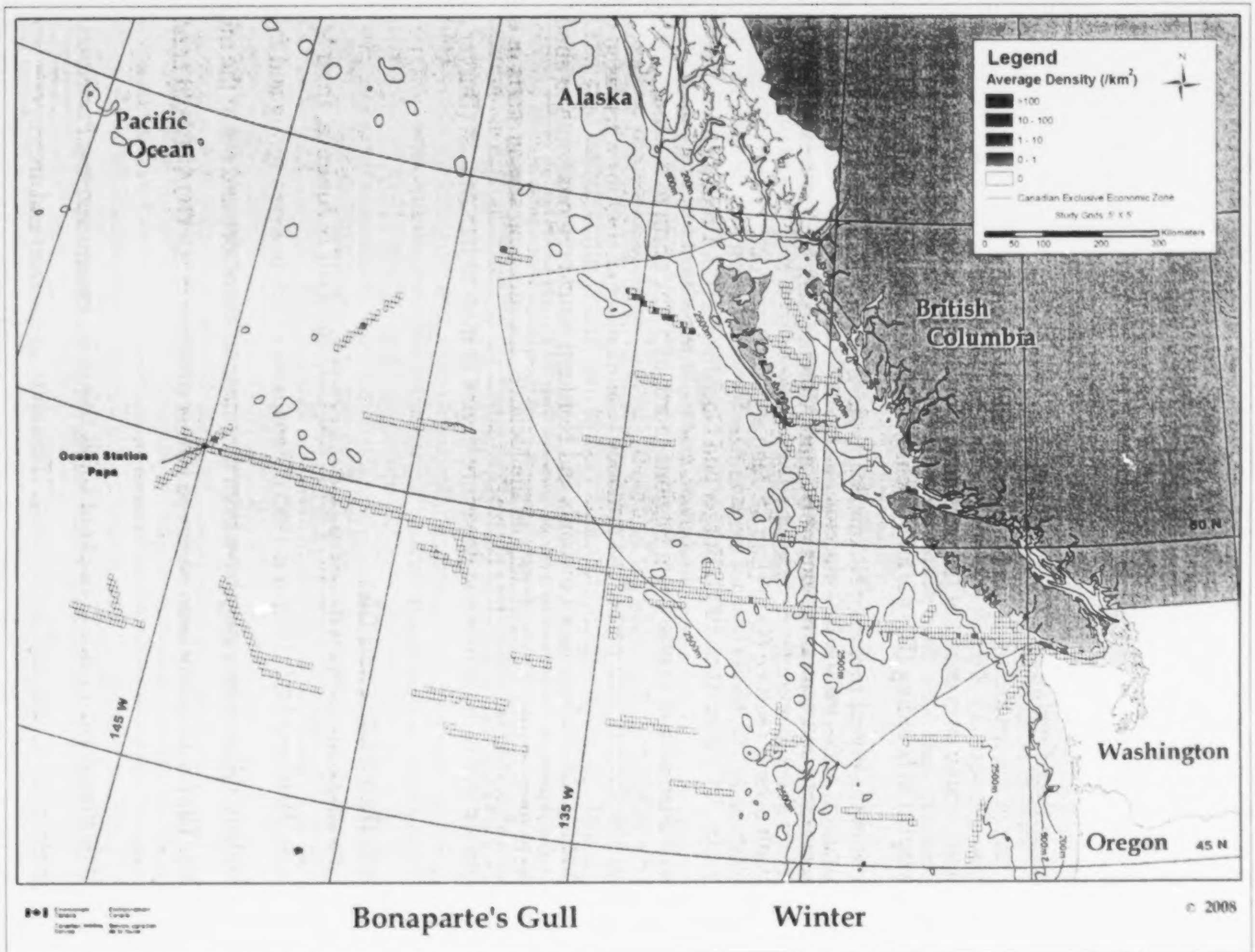

Figure 29C. Seasonal average grid cell densities of Bonaparte's Gulls.

3.1.8.1 Bonaparte's Gull *Chroicocephalus philadelphia*

3.1.8.1.1 Population and Conservation Status

The Bonaparte's Gull is a small, hooded gull that breeds only in N America. With an estimated global population >500,000 birds, the Bonaparte's Gull is considered by the IUCN to be a species of *Least Concern* (BirdLife International 2008). Kushlan *et al*. (2002) and Milko *et al.* (2003) list this as a species of *Moderate Conservation Concern* for N America and Canada, respectively.

3.1.8.1.2 Breeding Distribution and Chronology

This species is one of the smallest gulls in N America, and is a familiar and often abundant migrant and winter visitor over much of the continent. However, it is one of the least known of the gulls with respect to breeding (Burger and Gochfeld 2002). Bonaparte's Gulls nest in small colonies throughout the boreal region of N America, from western AK, southern Yukon Territory (YT), northern and central regions of BC and Alberta (AB), Saskatchewan and Ontario (ON), east to south central Quebec (QC) (Lac St. Jean at 48° N) and occasionally further east (e.g., Magdalene Is., QC) (Harrison 1983, Burger and Gochfeld 2002). Breeding in BC occurs through the Fraser Plateau and Fraser Basin Regions (north of 51°N, north to the southern Peace Lowlands and across the northern part of the province (Campbell *et al.* 1990b) whereas in ON, nesting is confined to the Hudson Bay Lowlands and Northern Shield regions south to about 47°N (C. Weseloh, pers. comm.). Depending on the location, the breeding season starts in early to late May, eggs are laid in June/July and departure begins in mid- to late August (Burger and Gochfeld 2002).

3.1.8.1.3 Oceanic Distribution and Diet

Bonaparte's Gulls winter along the Atlantic, Pacific and Gulf coasts of N America, from MA and BC, south to Cuba, Haiti and MX (Harrison 1983). Bonaparte's Gull is a rare spring and fall visitor to the northern GOA, where they have been encountered nearshore and out to the middle shelf (Day 2006). They have rarely been observed farther offshore in the GOA (Gould *et al.* 1982).

The marine diet of Bonaparte's Gulls consists of small fish (e.g., Pacific herring, Pacific sandlance, juvenile salmon) and euphausiids (e.g., *Thysanoessa raschii*) and amphipods (e.g., *Parathemisto pacifica*, *Calliopius laeviusculis*) (Vermeer *et al.* 1987b, Gillespie and Westrheim 1997). Bonaparte's Gulls have been observed foraging at tidal rips, convergences, and areas of

upwelling (Burger and Gochfeld 2002). Wahl *et al.* (2005) suggested that spring migration may coincide with herring spawning events (especially in the Strait of Georgia and Juan de Fuca Strait); their association with herring is also noted by Campbell *et al.* (1990b).

3.1.8.1.4 Spatial Distribution and *Average Grid Cell Density* in Study Area

Densities of Bonaparte's Gulls were low within the study area with few areas having *average grid cell densities* >1.0 bird/km^2. On a seasonal basis, they were most abundant during winter, and there were no summer records.

We encountered Bonaparte's Gull in spring on only a single occasion; a flock of five birds was observed on 6 May 2000 about 30 km south of Barkley Sound. This species was also rare during fall; the only two sightings of single Bonaparte's Gulls; both were seen in eastern Juan de Fuca Strait on 21 October 1997.

During late winter (February and March) Bonaparte's Gulls were found primarily offshore (including out to OSP), as well as occasionally along the continental slope and in Juan de Fuca Strait. The highest *average grid cell densities* were located about 50 km northeast and approximately 215 km northwest of Bowie Seamount.

This species has occurred in BC in every month of the year, and is coastally abundant in spring and fall, rare during summer and rare to very abundant locally in winter. The southbound dispersal starts as early as late July and continues into November, at which time the gulls may accumulate in high numbers in the Strait of Georgia and Juan de Fuca Strait (Campbell *et al.* 1990b).

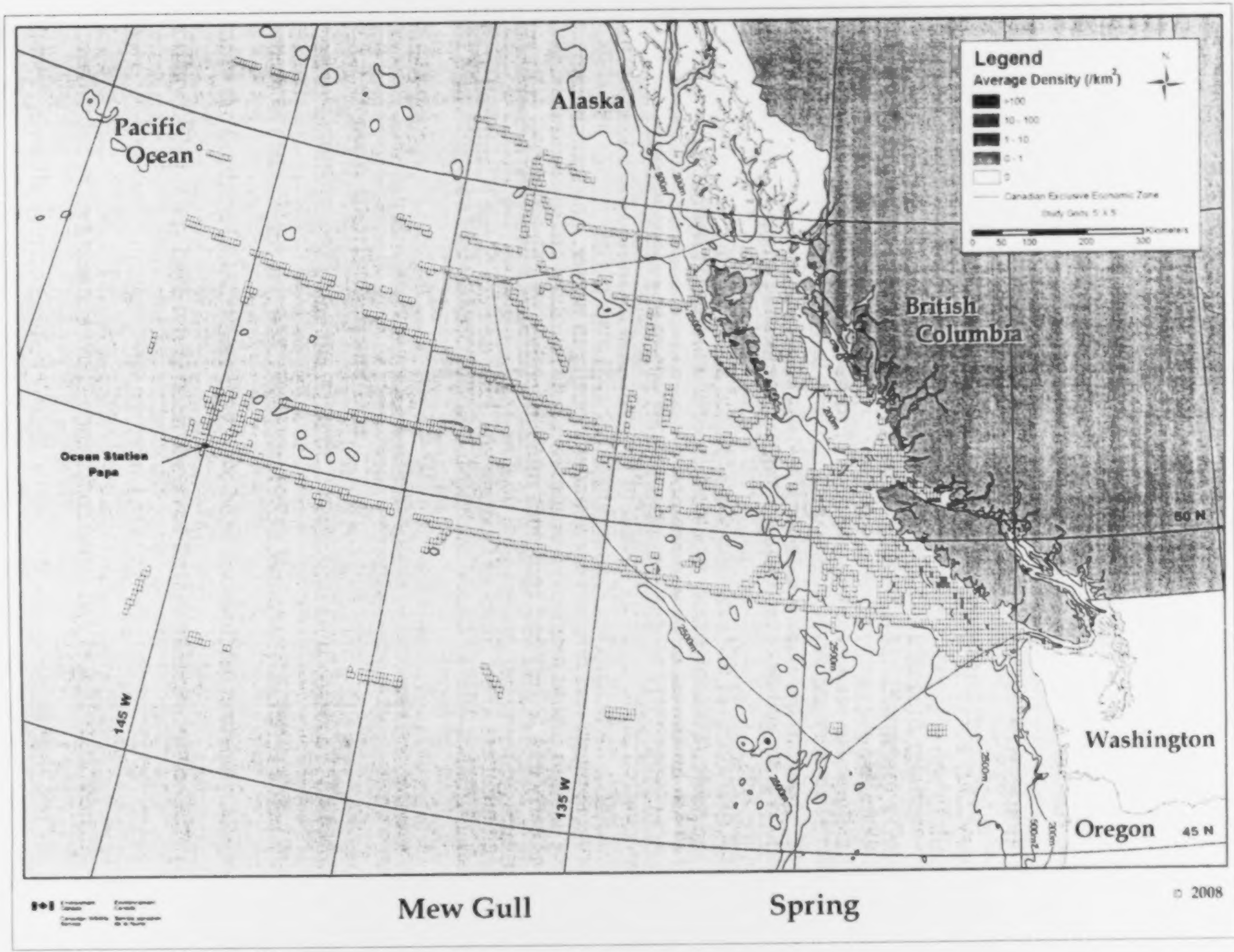

Figure 30A. Seasonal average grid cell densities of Mew Gulls.

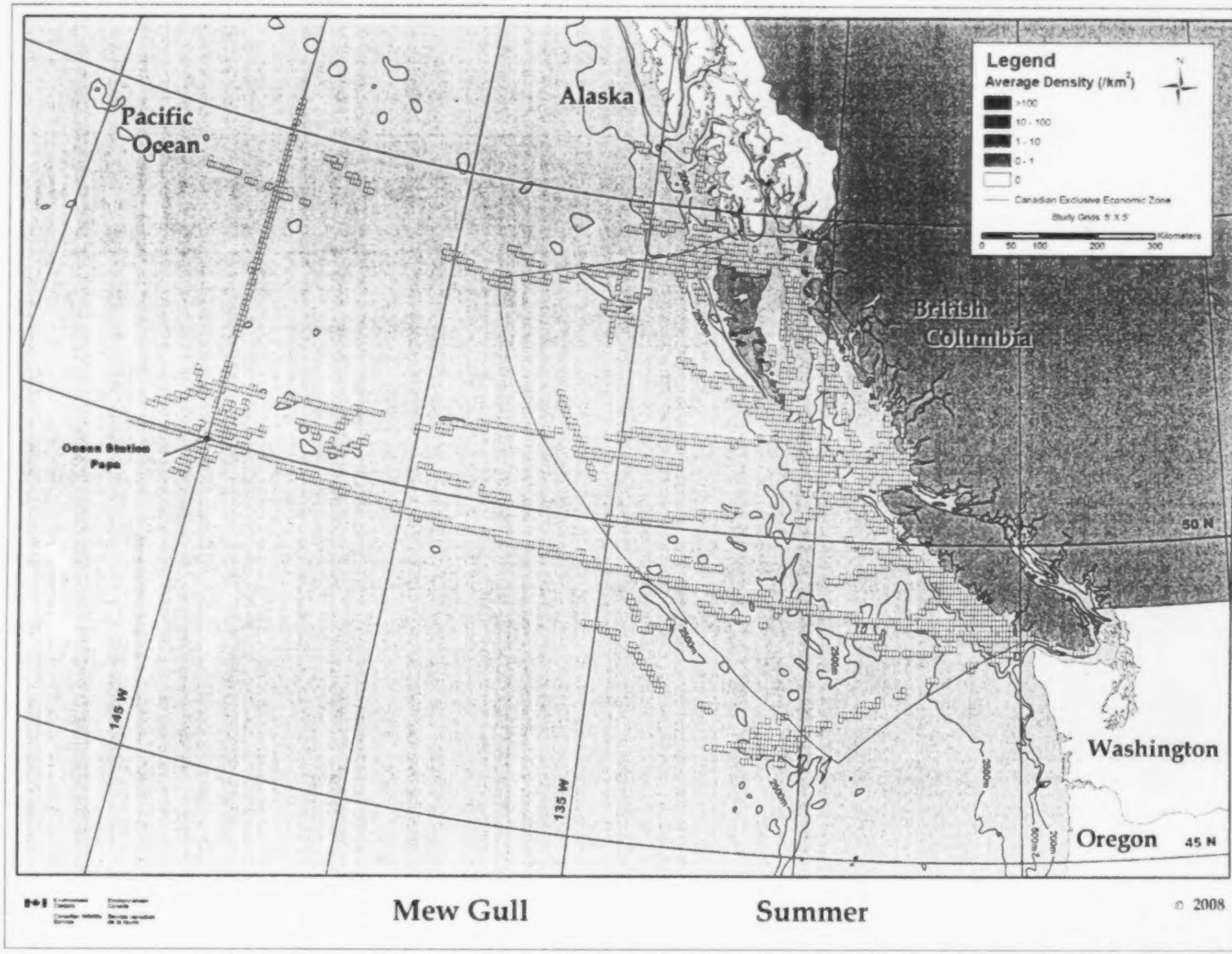

Figure 30B. Seasonal average grid cell densities of Mew Gulls.

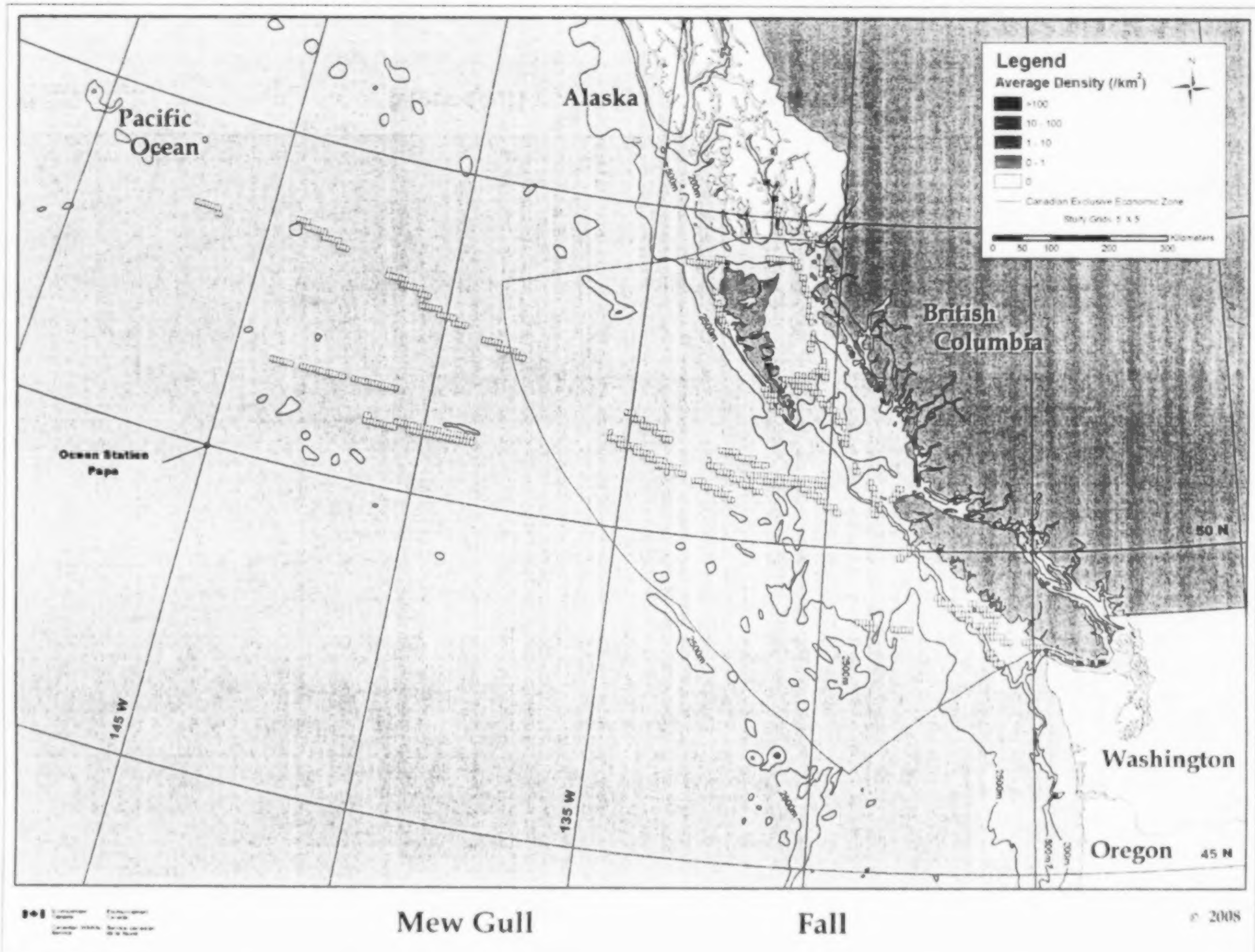

Figure 30C. Seasonal average grid cell densities of Mew Gulls.

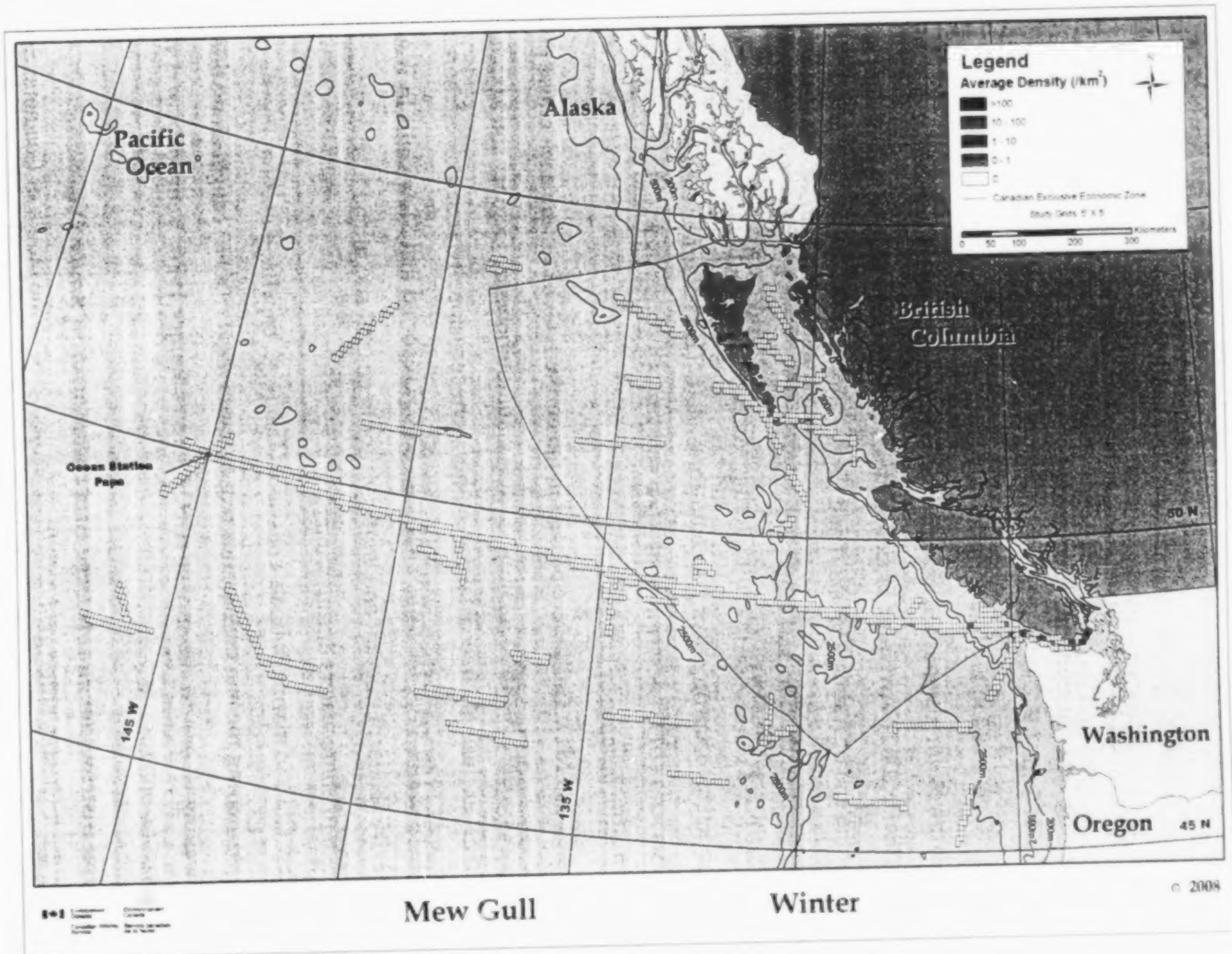

Figure 30D. Seasonal average grid cell densities of Mew Gulls.

3.1.8.2 Mew Gull *Larus canus*

3.1.8.2.1 Population and Conservation Status

The Mew Gull is found almost circumpolarly in the N Hemisphere. The global population is estimated at 4.4 million individuals and as a result they are considered by the IUCN to be a species of *Least Concern* (BirdLife International 2008) and *Not Currently at Risk* in N America and Canada (respectively, Kushlan *et al.* 2002, Milko *et al.* 2003).

3.1.8.2.2 Breeding Distribution and Chronology

Mew Gulls breeds from AK south to BC (throughout Vancouver Island, along the mainland coast to Prince Rupert, and in the interior primarily north of 57°N) and northwestern Canada, Iceland and northwestern Europe, and eastern Siberia (Harrison 1983, Campbell *et al.* (1990b, Moskoff and Bevier 2002). Arrival at breeding sites begins in early May with departure normally occurring near the end of August (Moskoff and Bevier 2002).

3.1.8.2.3 Oceanic Distribution and Diet

Mew Gulls were observed at high densities during winter and fall, with most found within the nearshore zone and all occurring over the continental shelf. This pattern is consistent with Moskoff and Bevier's (2002) description of Mew Gulls being a species found primarily on or adjacent to N Pacific beaches or estuaries.

Day (2006) stated that Mew Gulls were present in the northern GOA during each cruise (March, April, May, October and December), but were most common between October and March. They were found almost exclusively in coastal waters, but were occasionally seen well offshore (i.e., out to approximately 150 km offshore). Wahl *et al.* (2005) reported that Mew Gulls in WA are a common to locally abundant migrant and winter visitor in coastal and inland marine waters, and fairly common in offshore waters during winter.

The diet of Mew Gulls in marine habitats consists of fish (e.g., capelin, eulachon, Pacific herring, juvenile salmon), herring roe and euphausiids (e.g., *Thysanoessa raschii*) caught along tide lines or areas of upwelling, at or near the surface (DeGange and Sanger 1986, Vermeer *et al.* 1987b, Moskoff and Bevier 2002).

3.1.8.2.4 Spatial Distribution and *Average Grid Cell Density* in Study Area

During spring, the highest *average grid cell densities* occurred at the mouth of Caamano Sound, Rivers Inlet, and over La Perouse Bank. Mew Gulls were observed throughout the spring months (25 March - 4 June); early observations may have been birds migrating north to their breeding grounds. Most encounters during spring were of individuals or small flocks (fewer than 10

birds), however two large groupings were observed: a flock of 35 birds seen at the mouth of Caamano Sound, and a flock of 25 gulls at the mouth of Rivers Inlet, both in early June 1998. In summer the only record was of a Mew Gull observed over Swiftsure Bank on 24 June 2001. Although not widely distributed or abundant during fall, Mew Gulls occurred at *average grid cell densities* as high as 3.5 birds/km^2. All observations of Mew Gulls were within 20 km of land. The highest fall *average grid cell densities* were north of Dixon Entrance, off the southern tip of Calvert Island, and eastern Juan de Fuca Strait.

The highest *average grid cell densities* of Mew Gulls (15.0 birds/km^2) was observed during winter near Haro Strait, followed closely by areas in eastern Juan de Fuca Strait (almost 10.0 birds/km^2). All but one winter sighting took place in the southern portion of the study area (Juan de Fuca Strait and over La Perouse Bank); the exception was of a solitary Mew Gull seen in early February, east of Aristazabal Island.

Mew Gulls have also been observed in coastal BC in every month of the year, and are considered to be abundant to very abundant spring and fall migrants; common to very abundant in winter and uncommon to common during summer by Campbell *et al.* (1990b).

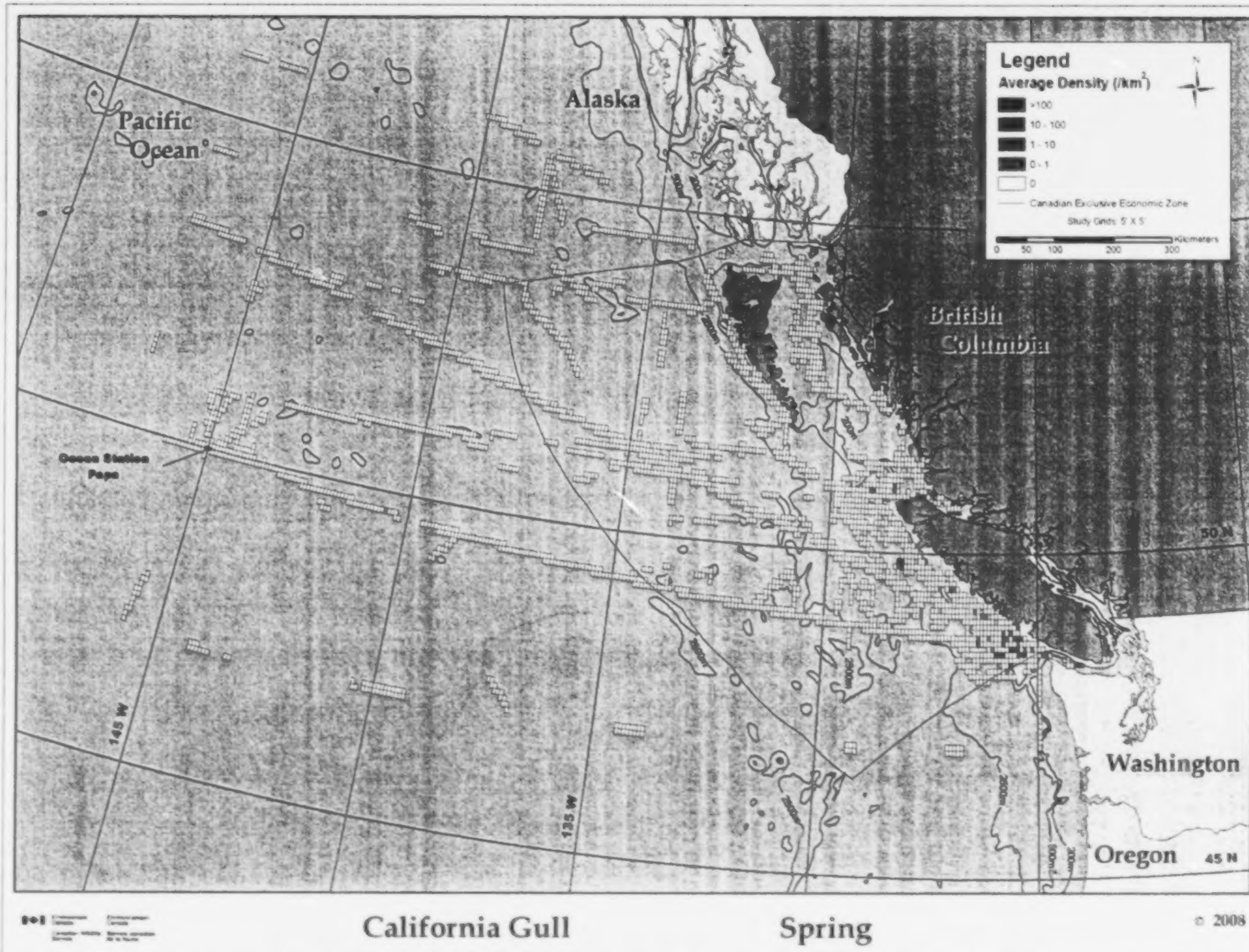

Figure 31A. Seasonal average grid cell densities of California Gulls.

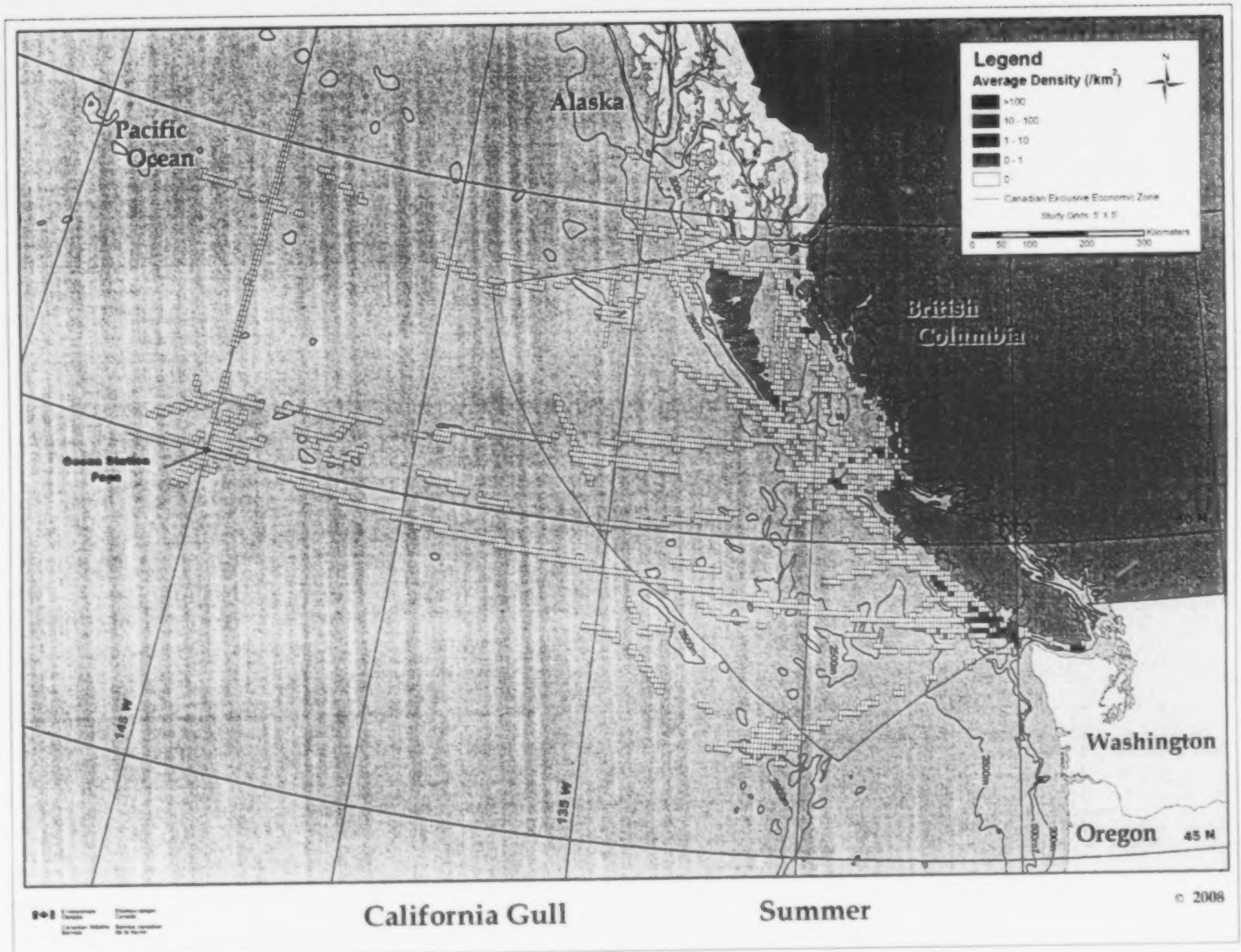

Figure 31B. Seasonal average grid cell densities of California Gulls.

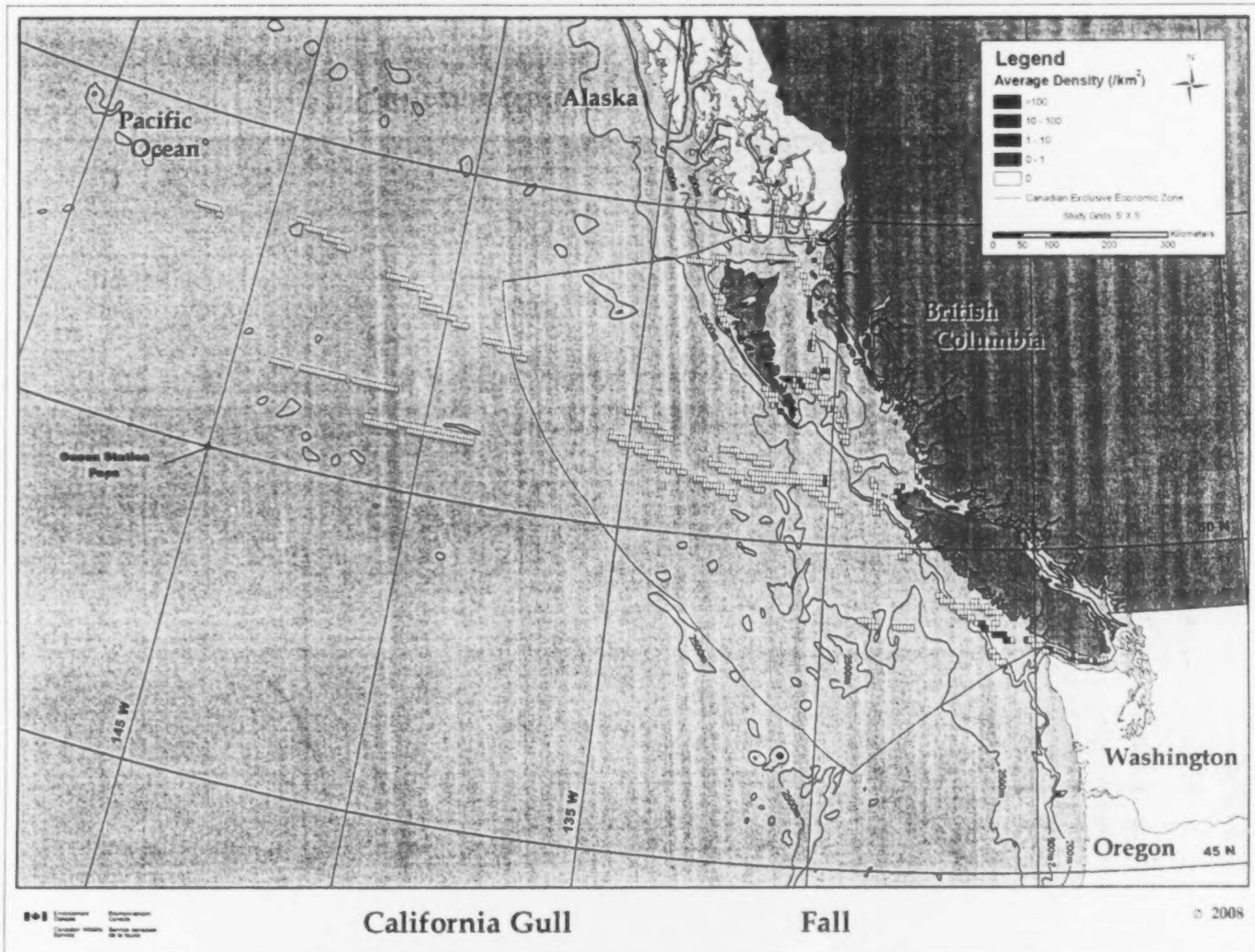

Figure 31C. Seasonal average grid cell densities of California Gulls.

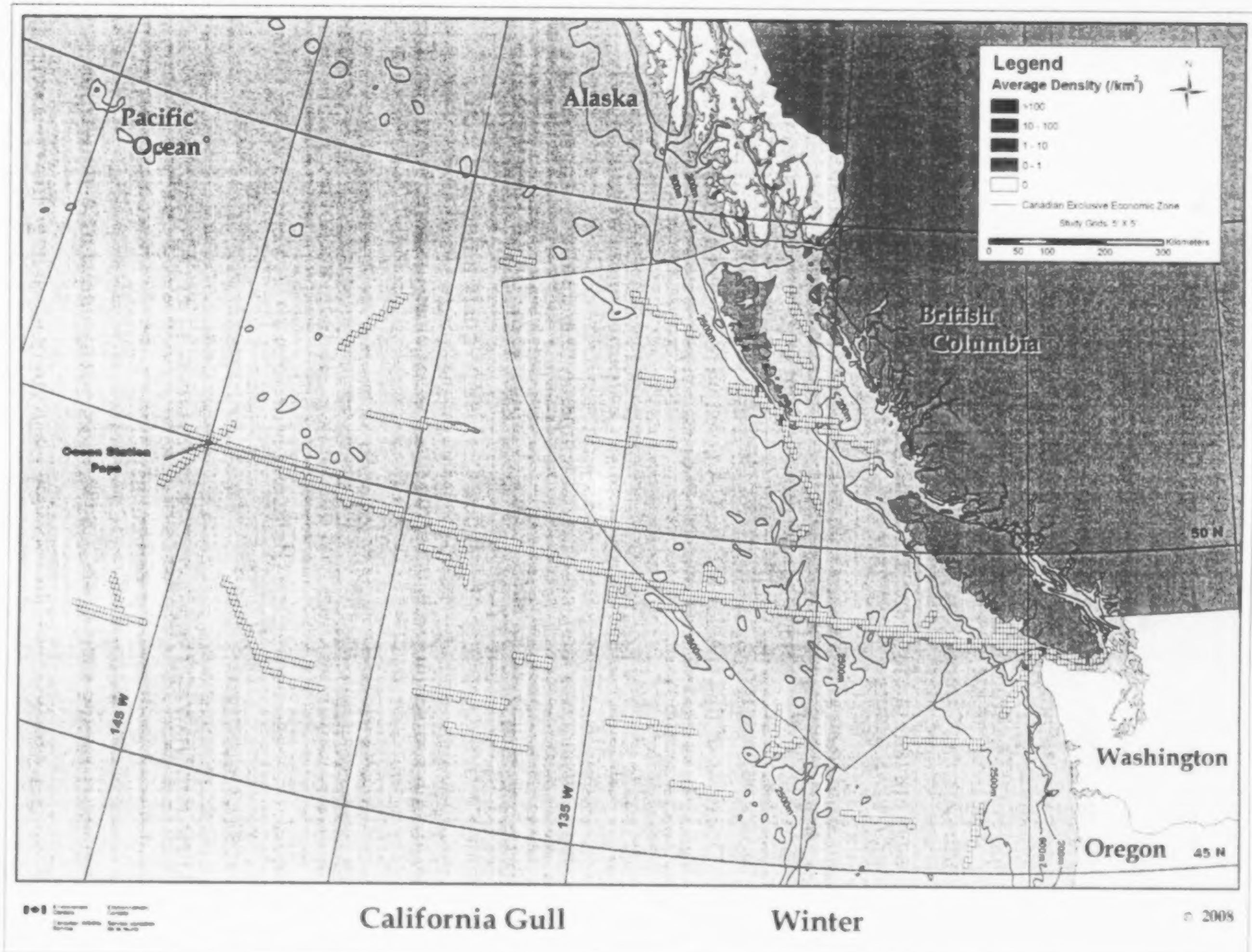

Figure 31D. Seasonal average grid cell densities of California Gulls.

3.1.8.3 California Gull *Larus californicus*

3.1.8.3.1 Population and Conservation Status

The California Gull has a stable population estimated at >410,000 breeders and is considered by the IUCN to be a species of *Least Concern* (BirdLife International 2008) and. as a species of *Moderate Conservation Concern* in N America and Canada, (respectively, Kushlan *et al.* 2002, Milko *et al.* 2003).

3.1.8.3.2 Breeding Distribution and Chronology

California Gulls nest in central southern BC and the boreal forest of northern AB and southern Northwest Territories (NT), through the prairie provinces, as well as in WA, OR, CA, Utah, Montana and North Dakota (Campbell *et al.* (1990b, Winkler 1996). Breeders arrive at colonies in March/April, eggs are laid in May/June and dispersal begins in August (Harrison 1983, Winkler 1996).

3.1.8.3.3 Oceanic Distribution and Diet

California Gulls overwinter along the Pacific coast from southern BC to Baja California (Winkler 1996). Densities of this species off the CA coast were always highest within 50 km of the mainland (Briggs *et al.* 1987).

Off the west coast of Vancouver Island during summer, California Gulls were negatively associated with depth, distance to land, sea-surface temperature and salinity, suggesting a preference for cold, low salinity, inner shelf waters (Vermeer *et al.* 1992). They were also positively associated with the presence of fish boats; which no doubt influenced their distribution. During fall, California Gulls occurred more often close to shore, but at significantly higher densities offshore (Vermeer *et al.* 1989).

In marine environments, California Gulls feed on fish (e.g., northern anchovies, Pacific herring, Pacific saury), squid, offal and herring roe (Baltz and Morejohn 1977, Vermeer 1992, Gillespie and Westrheim 1997).

3.1.8.3.4 Spatial Distribution and *Average Grid Cell Density* in Study Area

This species was observed in all seasons, particularly in the southern sub-regions; almost all birds were encountered over the shelf or shelfbreak/slope. Many immature and juvenile California Gulls likely are recorded as 'gull species', especially when large mixed-species flocks are encountered. As a consequence, their actual *average grid cell densities* may be higher than reported here.

Spring densities of California Gulls were low with only one grid cell (west of Barkley Sound) having an *average grid cell density* >1.0 bird/km^2. California Gulls were consistently observed over La Perouse, Amphitrite, and Swiftsure Banks. There was only one apparent observation of this gull species beyond the EEZ; a bird was identified as a California Gull in mid-March, >660 km from the nearest land.

The highest California Gull *average grid cell density* recorded during this study (>19.2 birds/km^2) was in Juan de Fuca Strait during summer. Densities approaching that level were also observed along the shelfbreak southwest of Barkley Sound. During summer, California Gulls again utilized the shelf/slope regions off the west coast of Vancouver Island. They were also well distributed throughout Queen Charlotte Sound and Hecate Strait, and in nearshore waters adjacent to Calvert and Banks Islands. The vast majority of summer observations of California Gulls occurred during August and early September; these likely were birds returning from their breeding areas before continuing further south for the winter.

During fall, California Gulls were again found primarily over the shelf and shelfbreak, especially west of Vancouver Island; with *average grid cell densities* as high as 14.0 birds/km^2. Unlike other seasons, birds were also observed along the southwest coast of the QCI.

California Gulls were encountered only six times during winter. Although the species reportedly winters in BC (Harrison 1983, Campbell *et al.* (1990b), California Gulls were seldom seen in offshore areas during the winter in this study. However, Campbell *et al.* (1990b) indicated that this species occurs in BC in all months and is considered to be a very common to abundant spring migrant, common along the south coast during summer (but rare to very rare on the north coast and the QCI), a common to very abundant fall migrant and uncommon to fairly common along the south coast in winter.

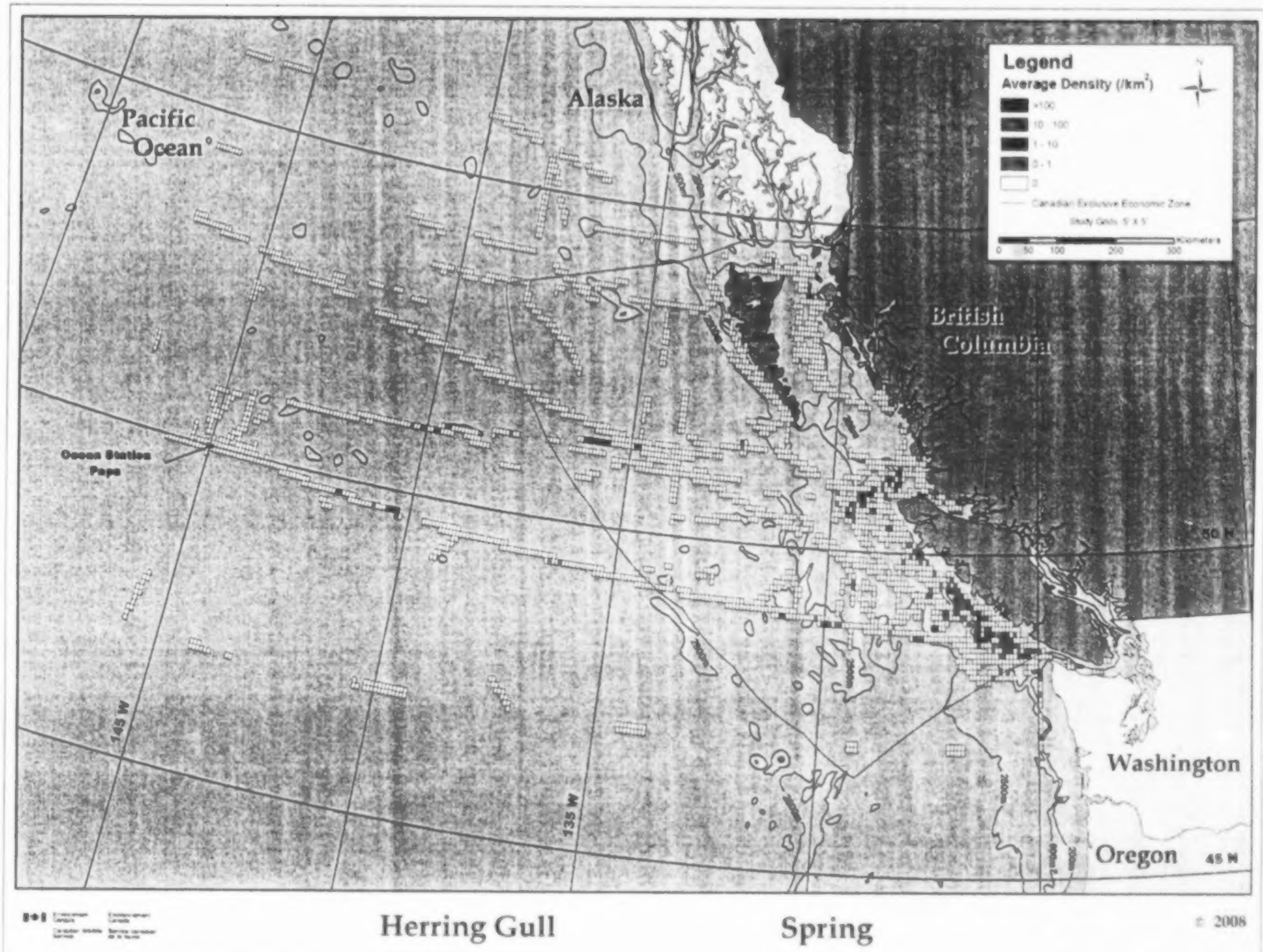

Figure 32A. Seasonal average grid cell densities of Herring Gulls.

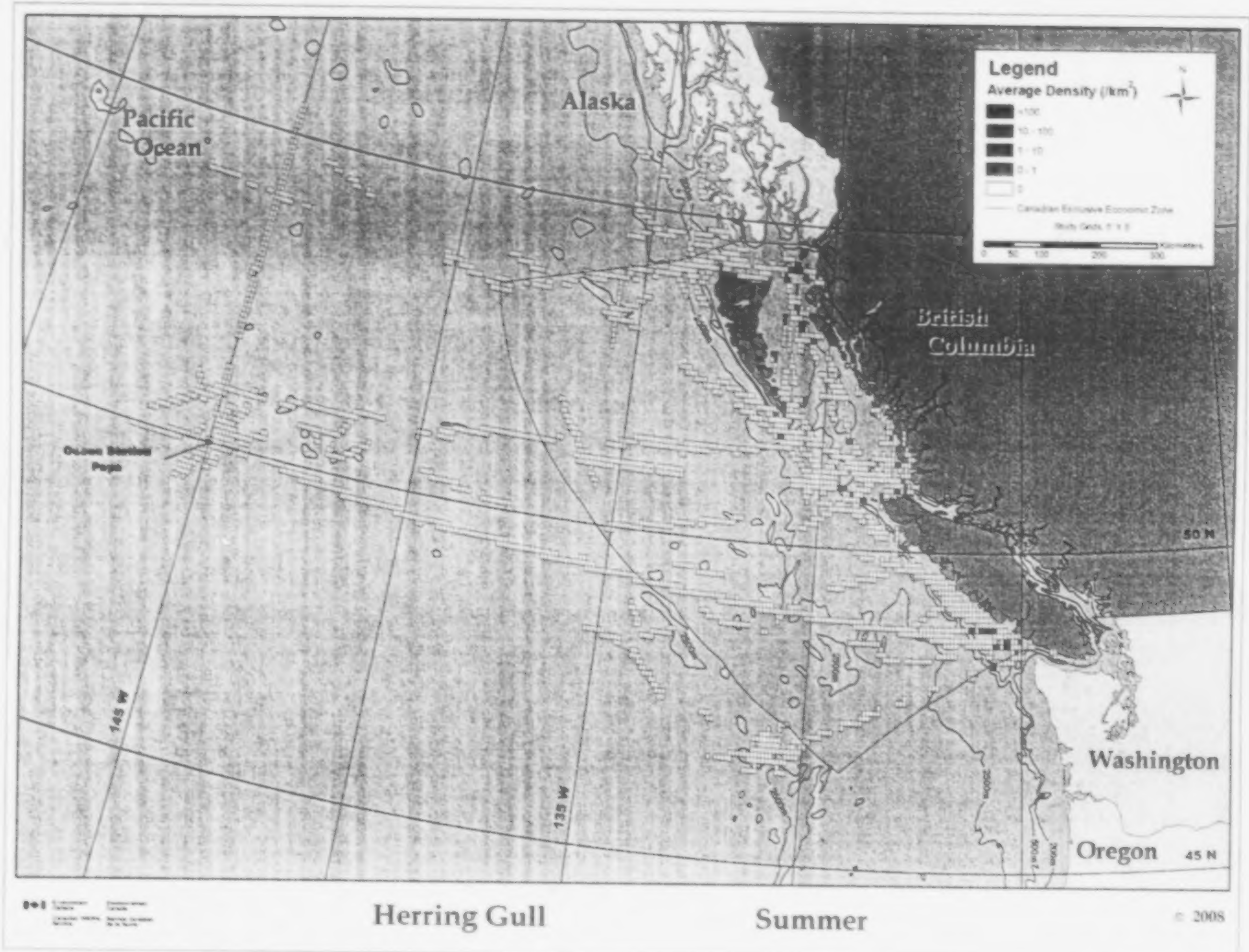

Figure 32B. Seasonal average grid cell densities of Herring Gulls.

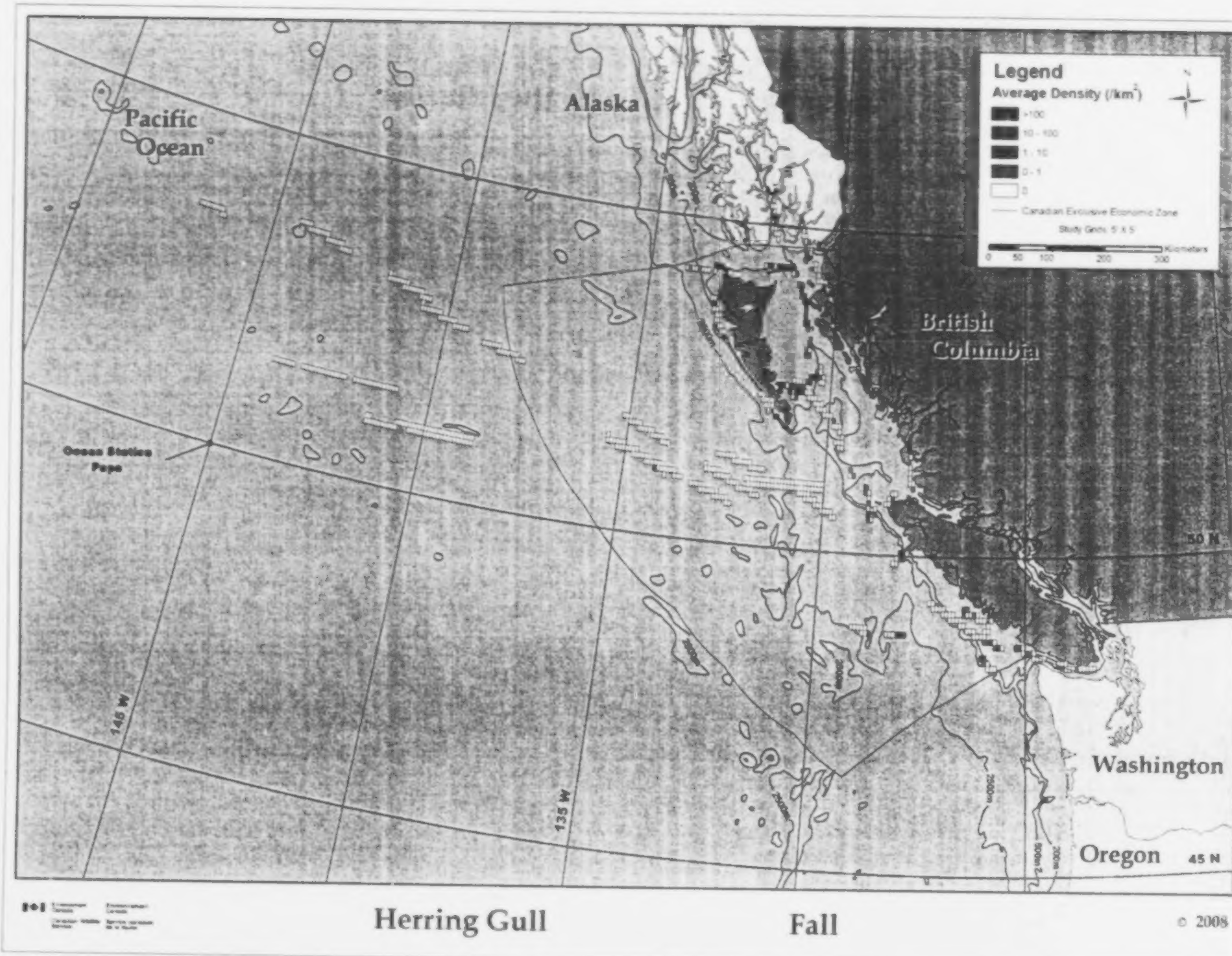

Figure 32C. Seasonal average grid cell densities of Herring Gulls.

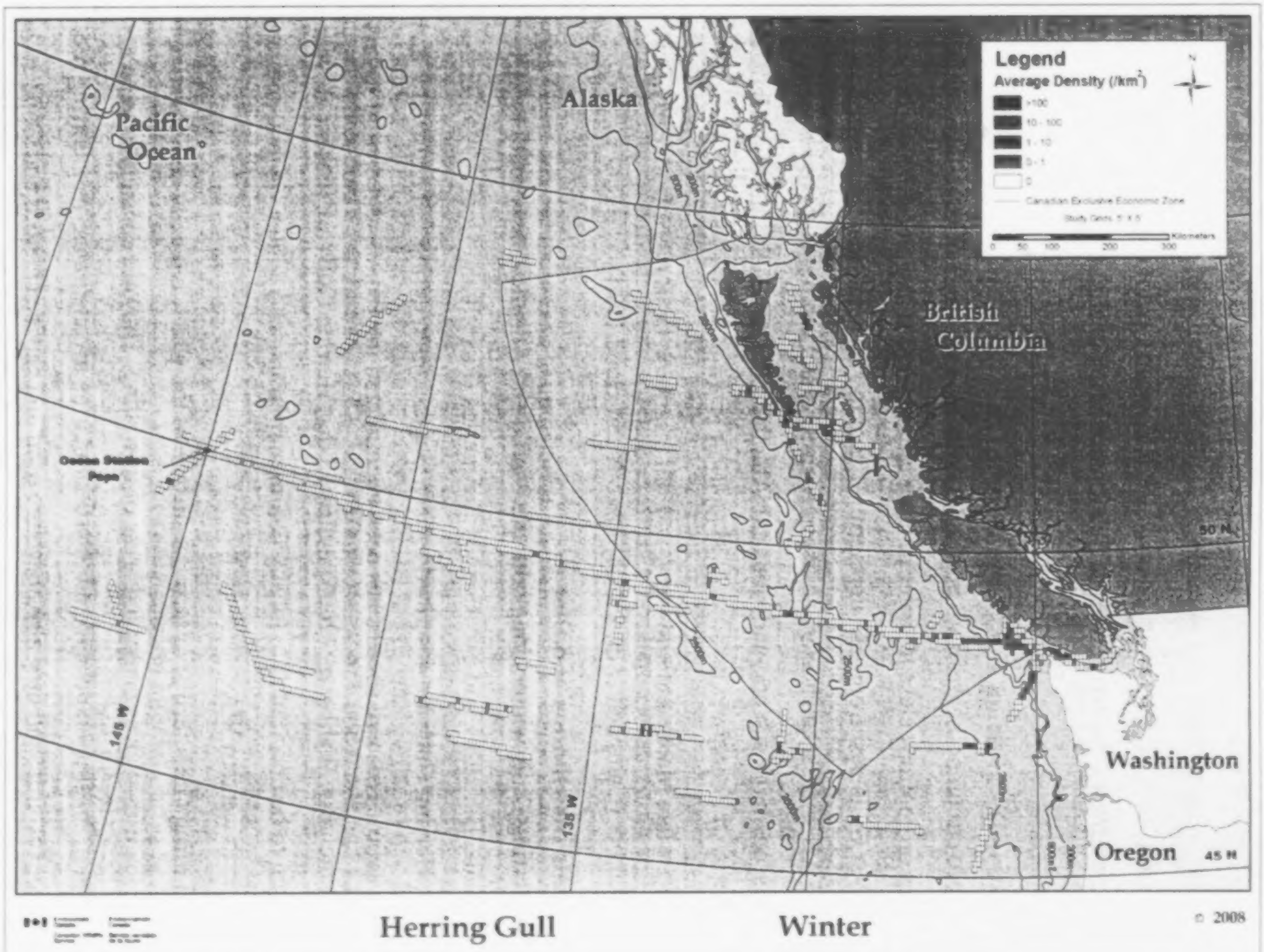

Figure 32D. Seasonal average grid cell densities of Herring Gulls.

3.1.8.4 Herring Gull *Larus argentatus*

3.1.8.4.1 Population and Conservation Status

Herring Gulls have a global population estimated at three million individuals distributed across N America, Asia, and Europe. Globally, the Herring Gull is considered by the IUCN to be a species of *Least Concern* (BirdLife International 2008). Kushlan *et al*. (2002) list the Herring Gull as a species of *Low Conservation Concern* for N America, but it is considered to be of *Moderate Conservation Concern* in Canada due to population declines in eastern Canada (Milko *et al.* 2003).

3.1.8.4.2 Breeding Distribution and Chronology

Herring Gulls are circumpolar breeders, nesting in colonies on islands in large lakes or in marine areas, as well as on rooftops close to water in large cities (Pierotti and Good 1994). In N America, Herring Gulls nest from AK, northern YT east to NL, south to south-central BC, through central AB and Saskatchewan, southern Manitoba and southern ON to northern Minnesota, Wisconsin, New York, and along the Atlantic coast to South Carolina (Harrison 1983, Campbell *et al.* (1990b). Along the west coast of N America, spring migration occurs primarily between late March and mid-May, and fall migration takes place from early September through late October (Campbell *et al.* 1990b, Pierotti and Good 1994).

3.1.8.4.3 Oceanic Distribution and Diet

N American Herring Gulls winter along both the Pacific and Atlantic coasts south to MX, Panama, Bermuda, Barbados, and occasionally S America (Pierotti and Good 1994). In the northern GOA, Herring Gulls are described as rare to uncommon during fall and winter and rare in spring (Day 2006). This gull species has been encountered in offshore and coastal waters of BC throughout the year. Wahl *et al.* (2005) indicated that Herring Gulls are present all year long, considering them to be uncommon to locally common migrants and winter visitors, and rare summer visitors, to western WA.

While at sea, Herring Gulls feed at or near the surface of the water, typically congregating near oceanographic features such as banks and areas of upwelling. They are considered to be a generalist predator, feeding on pelagic and intertidal marine invertebrates, fish, herring roe, insects and other seabirds; and they also scavenge offal and carrion (Pierotti and Good 1994, Gillespie and Westrheim 1997).

3.1.8.4.4 Spatial Distribution and *Average Grid Cell Density* in Study Area

Herring Gulls were present along BC's coast in all seasons, over the shelf and shelfbreak; those seen offshore were apparently present only during winter and spring. *Average grid cell densities* were generally low other than during fall. As was noted for the California Gull, difficulties in identifying this species, especially immature birds in large mixed-species flocks, likely resulted in underestimating the *average grid cell densities* of Herring Gulls.

During spring, Herring Gulls were present throughout the survey area, ranging from Dixon Entrance and northern Hecate Strait south to offshore of Grays Harbor. However, the majority of birds were observed over La Perouse, Amphitrite, Swiftsure, and Cook Banks. They were commonly encountered in low numbers offshore. The most offshore record was roughly 730 km from land. The highest spring Herring Gull *average grid cell density* (8.3 birds/km^2) was 30 km north of Cape Scott; and the largest flock (29 birds) was encountered about 20 km southwest of Estevan Point.

The summer distribution of Herring Gulls was restricted to the continental shelf and shelfbreak. Numbers were generally low with only a few areas having *average grid cell densities* higher than 1.0 bird/km^2; areas with the highest densities were in northern Hecate Strait and along northern Vancouver Island.

Herring Gulls were at their peak abundance during fall, with *average grid cell densities* as high as 45.1 birds/km^2. Although flocks were generally small (i.e., fewer than five birds), 133 Herring Gulls were encountered over two adjacent transects, approximately 25 km east of Rankine Island on 5 October 1996. The distribution of Herring Gulls in fall was similar to that found during summer, other than a few birds seen farther offshore (west of Cape Beale and Cape Scott).

In winter, Herring Gulls were most widely dispersed; they were observed from northern Hecate Strait south to offshore of OR and offshore beyond OSP. Winter *average grid cell densities* were generally low.

Herring Gulls are considered to be common to very common migrant during spring and fall migrations; fairly common to common in winter and rare in summer (Campbell *et al.* 1990b).

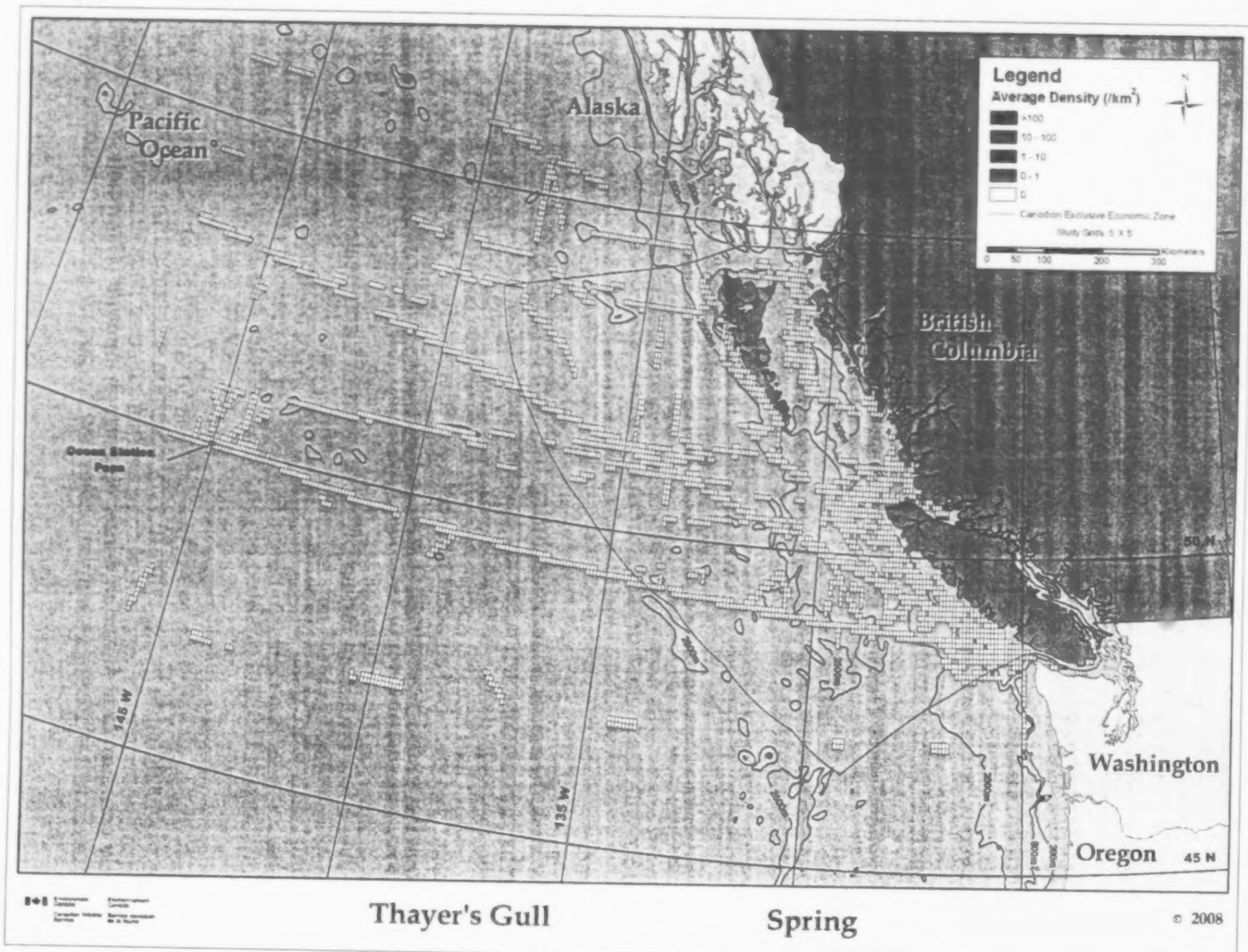

Figure 33A. Seasonal average grid cell densities of Thayer's Gulls.

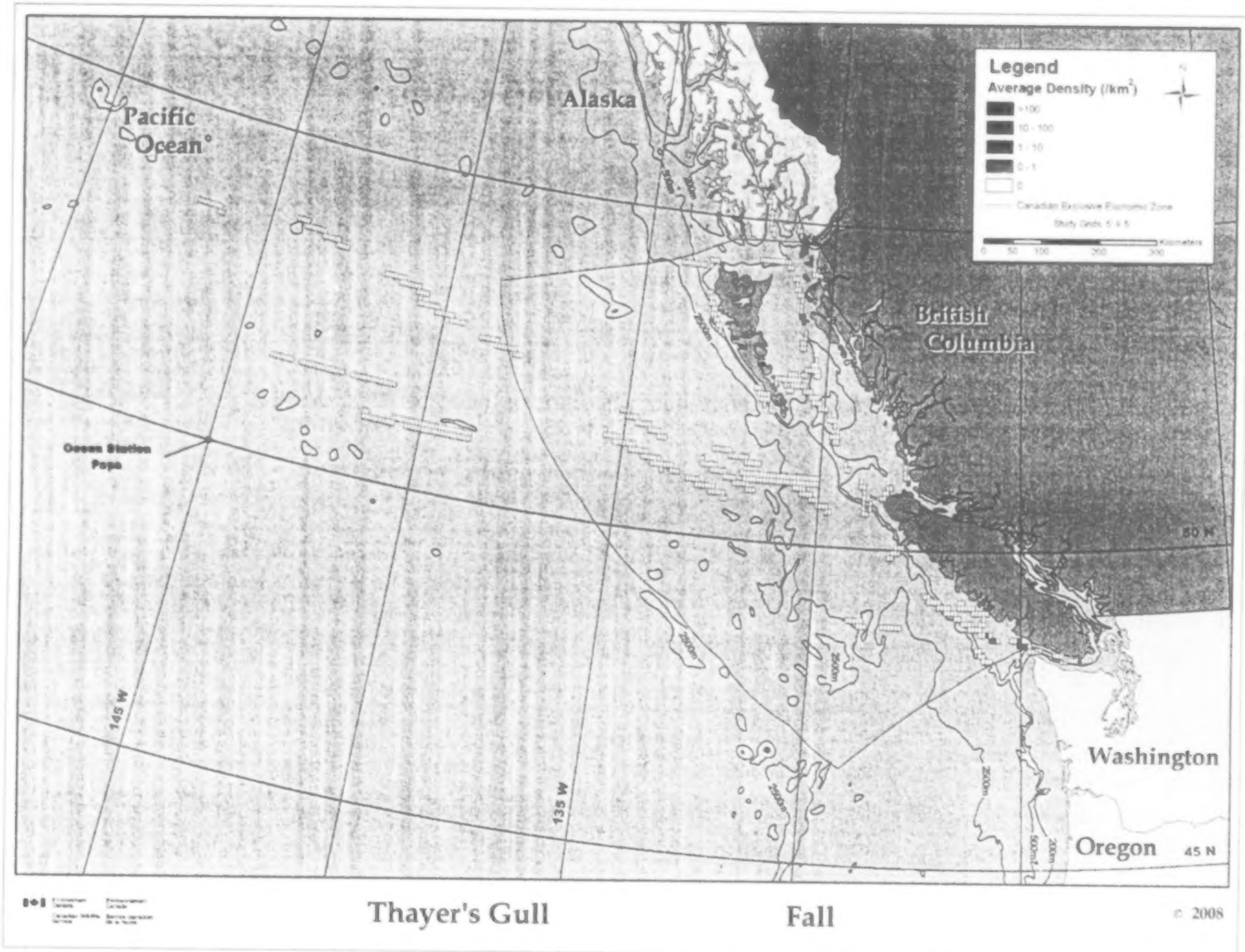

Figure 33B. Seasonal average grid cell densities of Thayer's Gulls.

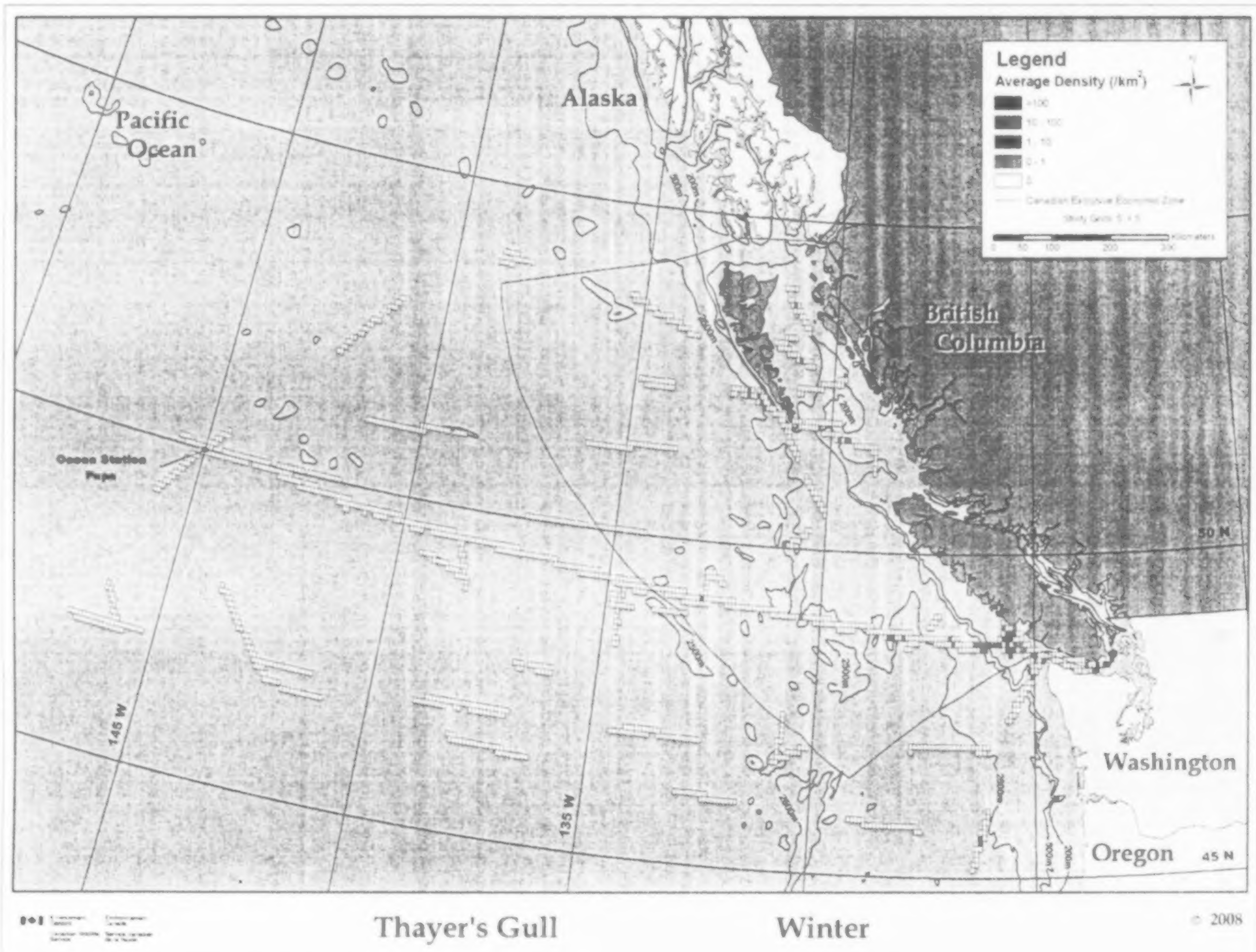

Figure 33C. Seasonal average grid cell densities of Thayer's Gulls.

3.1.8.5 Thayer's Gull *Larus thayeri*

3.1.8.5.1 Breeding Distribution and Chronology, and Population and Conservation Status

We have combined two sections (*Breeding Distribution and Chronology*, and *Population and Conservation Status*) due to the fact that the taxonomy of Thayer's and Iceland (*L. glaucoides)* gulls is complex and unsettled. The following summarizes some of the discussion on the taxonomy of these species (or subspecies).

Thayer's and Iceland gulls are considered by some to be a single, but variable species and that the taxon *kumlieni* is a hybrid population between the nominate *glaucoides* (to the east) and *thayeri* (to the west). Birds that nest along the west coast of Greenland (south of 70° N) and on the east coast of Greenland, are considered to be *L. glaucoides glaucoides*; birds that nest east, south, and southwest of Baffin Island, northwestern QC, and west to Southampton Island are considered to be Kumlien's Gull (*L. glaucoides kumlieni*); and birds that nest northwestern Greenland and in the Canadian Arctic, north and west of the *kumlieni* taxon, are considered to be Thayer's Gull. However, where the breeding ranges of *kumlieni* and *thayeri* overlap (east Baffin Island, east Southampton Island, Digges Sound), the gulls are as dark or darker than the *thayeri* 'type' (Snell 2002, Roberson 2004).

In contrast, the American Ornithologists' Union currently considers the two as seperate but closely related species. They consider the Thayer's Gull to be monotypic; whereas, Iceland Gull is separated into two subspecies; the nominate *glaucoides* (which nests mostly in Greenland) and *kumlieni* (which nests mostly in extreme northeastern Canada) (Snell 2002, Roberson 2004).

Departure for the northern breeding grounds takes place from late Mar through Apr; and arrival at the colonies occurs during May, with egg laying beginning in mid-May (Campbell *et al.* 1990b, Snell 2002). Thayer's Gulls have usually left the breeding grounds by the end of Aug (Harrison 1983).

While the debate over the Thayer's/Iceland taxonomy continues, we have treated Thayer's and Iceland gulls as separate species. Although the total breeding population is thought to consist approximately of only 12,000 birds (Snell 2002), Thayer's Gull is listed globally by the IUCN as a species of *Least Concern* (BirdLife International 2008). Kushlan *et al.* (2002) and Milko *et al.* (2003) list Thayer's Gull as a species of *Moderate Conservation Concern* for N America and Canada, respectively.

3.1.8.5.2 Oceanic Distribution and Diet

Most Thayer's Gull appear to winter in coastal areas of the Pacific northwest, as well as less frequently in the Great Lakes region, and infrequently, on the East coast, the continental interior, and the Gulf Coast (Snell 2002, Roberson 2004). Thayer's Gulls are very rare in the northern GOA (Day 2006), and are only abundant off WA from early October through mid-April (Wahl *et al.* 2005).

There is little information on the marine diet of Thayer's Gull, other than they feed on invertebrates, fish, carrion, and offal, which they capture at or just below the surface (Snell 2002).

3.1.8.5.3 Spatial Distribution and *Average Grid Cell Density* in Study Area

Thayer's Gulls were common within the study area only during winter. There was only a single record of the species during spring (observed about 40 km southwest of Barkley Sound on 2 May 2002), and there were no observations of Thayer's Gulls in summer.

There were only 19 sightings of Thayer's Gulls during fall; all birds were encountered close to shore, from Juan de Fuca Strait to north of Dundas Island. The earliest we encountered Thayer's Gull during fall was 22 September 2005.

The highest *average grid cell density* during winter (16.8 birds/km^2) in the eastern portion of Juan de Fuca Strait; a result no doubt of a flock of 30 Thayer's Gulls observed on 25 February 2005. Thayer's Gulls were abundant off southwest Vancouver Island, but were also seen in Queen Charlotte Sound and Hecate Strait; and a few were observed along the eastern half of Line P. The maximum distance from land a Thayer's Gull was seen was approximately 355 km west of Brooks Peninsula.

Thayer's Gulls have been observed in BC in every month, with peak numbers from September through March/early April (Campbell *et al.* 1990b). Although migrants begin to arrive in coastal BC as early as late July/early August, the peak immigration generally starts in September, with maximum numbers occurring in December or January (Campbell *et al.* 1990b).

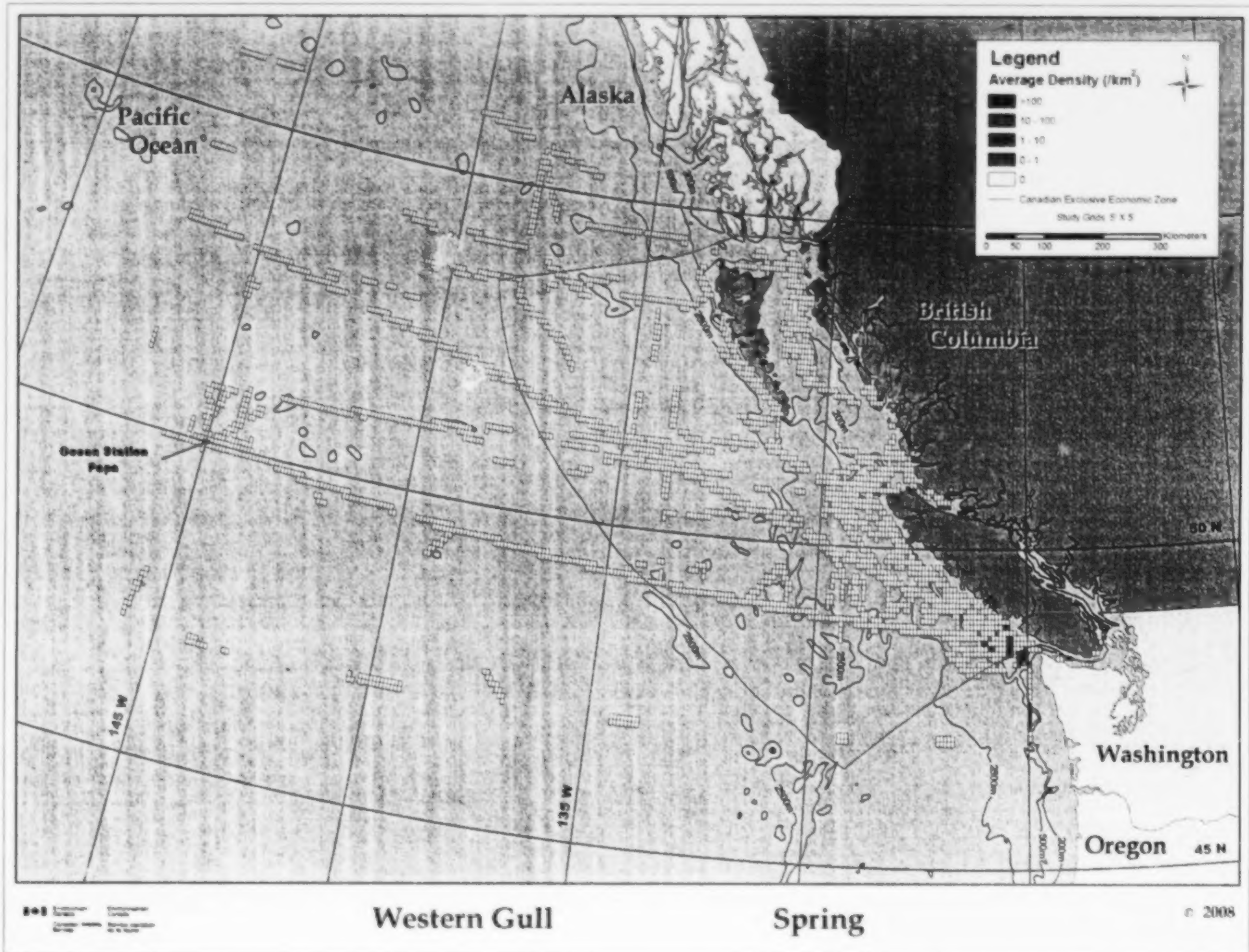

Figure 34A. Seasonal average grid cell densities of Western Gulls.

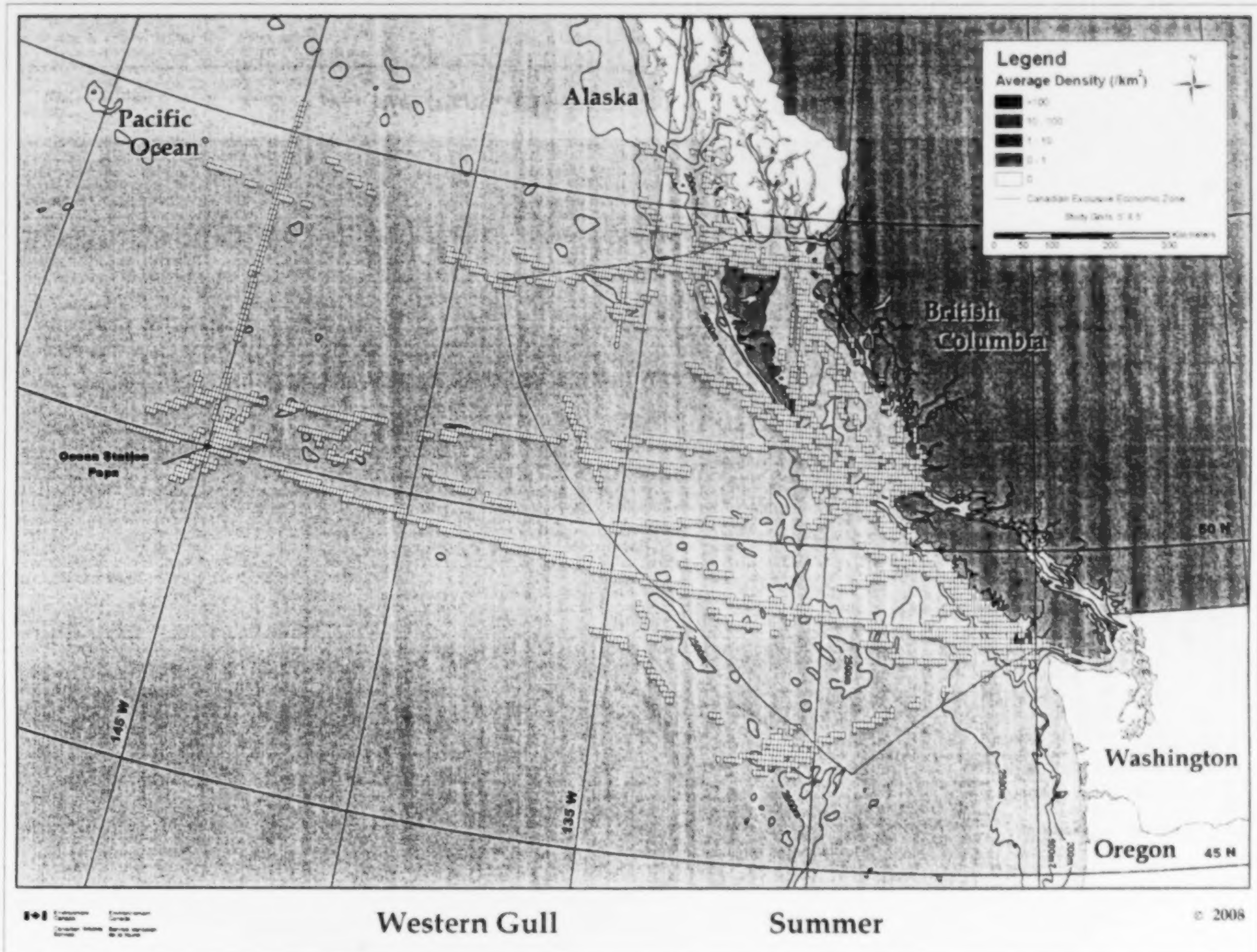

Figure 34B. Seasonal average grid cell densities of Western Gulls.

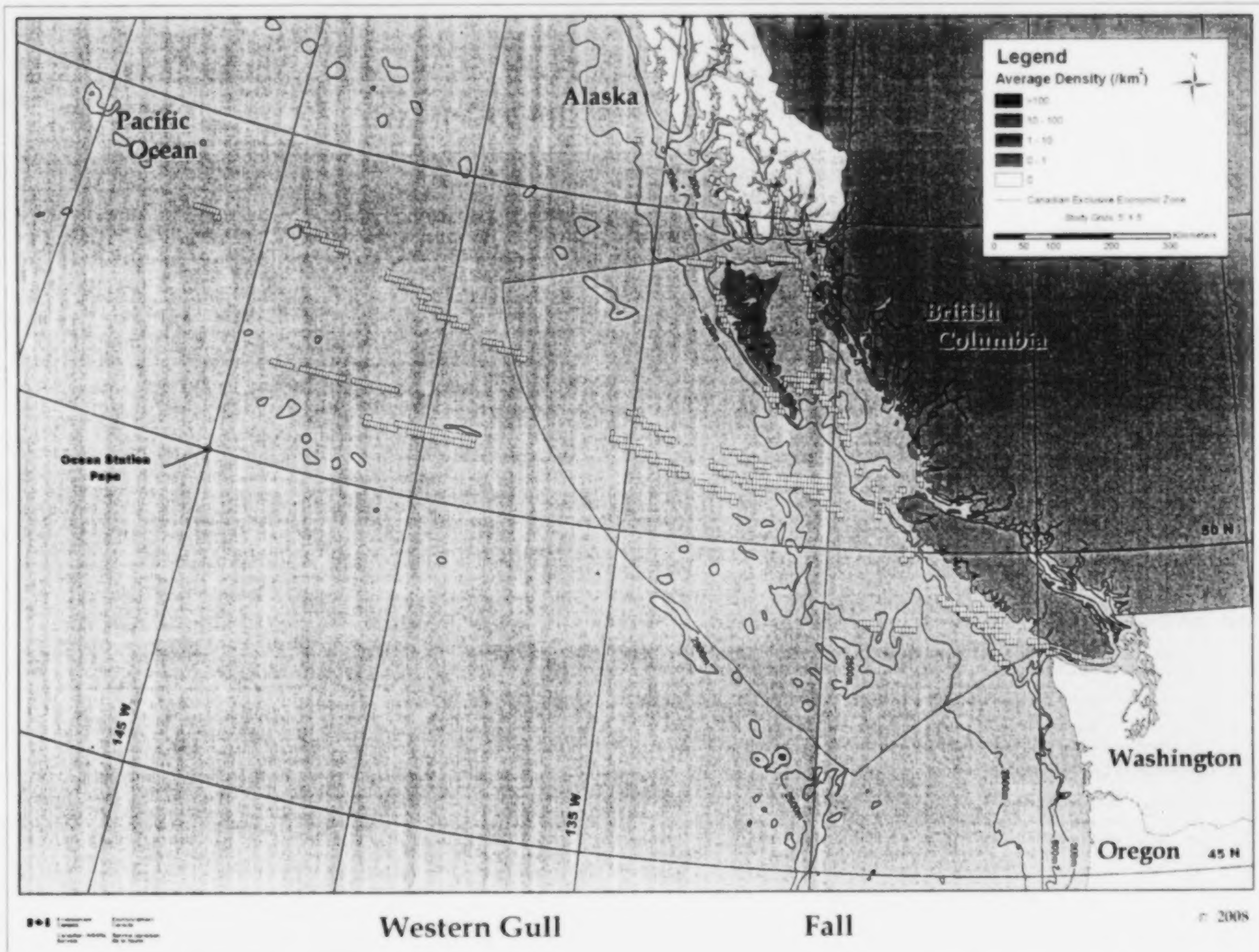

Figure 34C. Seasonal average grid cell densities of Western Gulls.

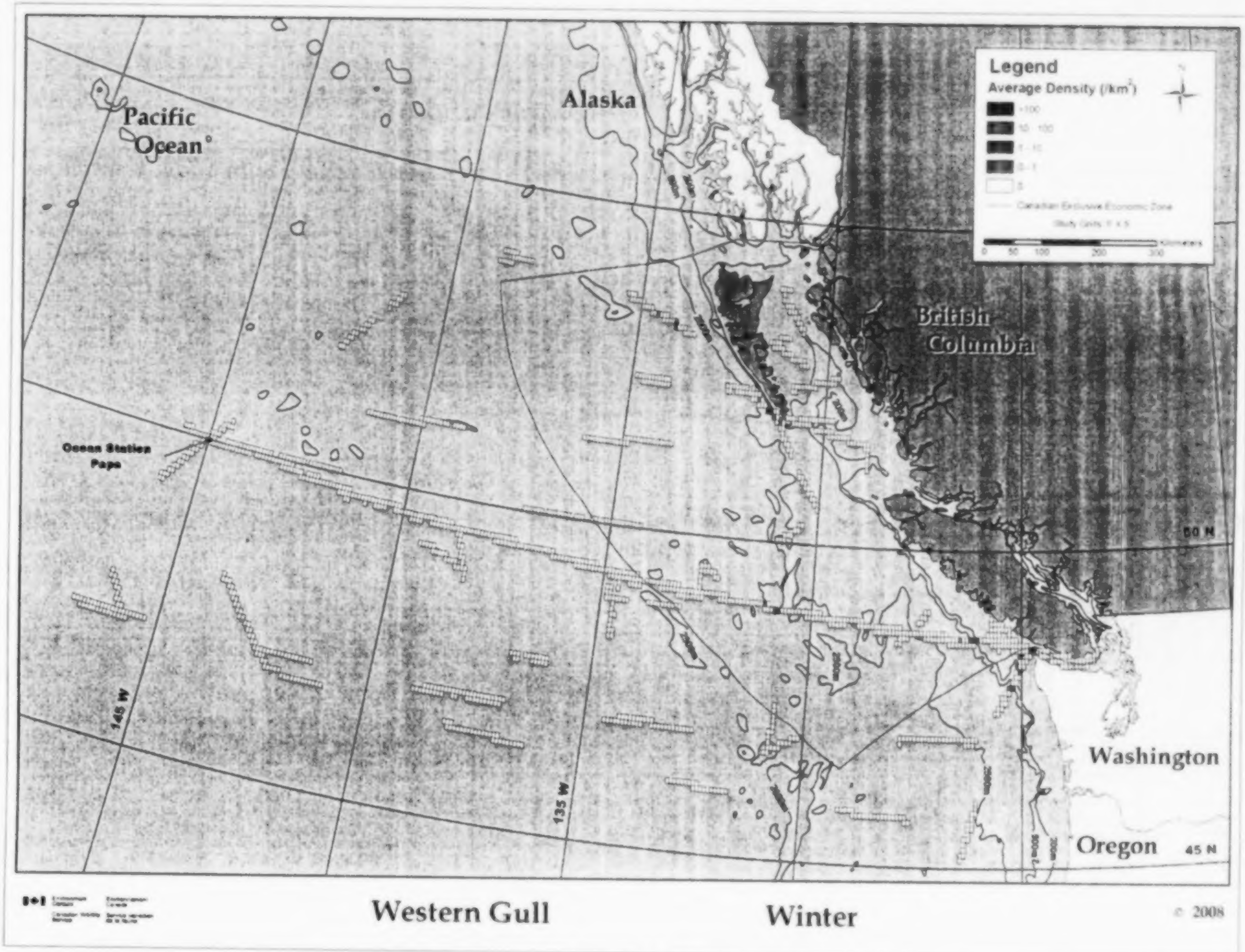

Figure 34D. Seasonal average grid cell densities of Western Gulls.

3.1.8.6 Western Gull *Larus occidentalis*

3.1.8.6.1 Population and Conservation Status

The global population estimates range from 80,000 (Pierotti and Annett 1995) to 120,000 individuals (BirdLife International 2008). The Western Gull is considered by the IUCN to globally be a species of *Least Concern* (BirdLife International 2008); and, Kushlan *et al.* (2002) and Milko *et al.* (2003) rank it as a species of *Low Conservation Concern* for N America and Canada, respectively

3.1.8.6.2 Breeding Distribution and Chronology

The Western Gull is a common species to western N America, nesting along the Pacific coast from Baja California to WA (Pierotti and Annett 1995). Western Gull and Glaucous-winged Gull (*Larus glaucescens*) pairs have been reported on territory on Cleland Island (Campbell and Stirling 1968). However, without documented information on nests, eggs, young, etc. resulting from pure Western Gull pairs, this species is not currently considered to be a breeding species within the province (Campbell *et al.* 1990b).

The breeding season begins in mid-April and continues until late August (Pierotti and Annett 1995).

3.1.8.6.3 Oceanic Distribution and Diet

Western Gulls winter throughout their breeding range with extensions to the north into southern BC and south to the tip of the Baja Peninsula; they are primarily found relatively close to shore (Pierotti and Annett 1995). Along the coast of WA, Western Gulls are present year-round and are fairly common on the WA side of Juan de Fuca Strait (Wahl *et al.* 2005).

Western Gulls are generalist predators known to congregate around bathymetric features that tend to concentrate their prey items, which include small squids, forage fish (e.g., northern anchovy), zooplankton, offal and carrion, at or near the surface (Hunt and Butler 1980, Pierotti and Annett 1995).

3.1.8.6.4 Spatial Distribution and *Average Grid Cell Density* in Study Area

All of the reported sightings of Western Gulls are considered here to be that of true Westerns; however, because of hybridization being quite common, as well as the possibility of misidentification of large immature gulls, it is difficult to say whether the following clearly reflects the marine distribution and abundance of Western Gulls in the study area.

The spring distribution of Western Gulls within the study area was mainly limited to the southern sub-regions. Most observations were from the La Perouse and Swiftsure Banks area, and all

sightings were from the shelf/slope regions. The highest *average grid cell densities* occurred seaward of the shelfbreak, northwest of Grays Harbor. They were also observed off the northern Vancouver Island and southwest of Calvert Island. Most commonly, one or two birds were encountered; the largest grouping of Western Gulls consisted of six birds.

In summer, observations of Western Gulls were limited only to an area southwest of Cape Beale. The species was equally as rare during fall; only two Western Gulls were observed then (one south of Calvert Island and one west of Banks Island).

Western Gulls were relatively common during winter with birds observed at the shelfbreak (off northern WA and southwest Vancouver Island) west to approximately 265 km from land. All winter sightings were of one to two birds.

This gull species has been recorded in BC in all months. They are considered to be an uncommon to fairly common resident of the southwest coast of Vancouver Island, a very rare to rare summer visitor, rare to uncommon winter visitor to the Strait of Georgia and Juan de Fuca Strait, and very rare coastally elsewhere in the province (Campbell *et al.* 1990b).

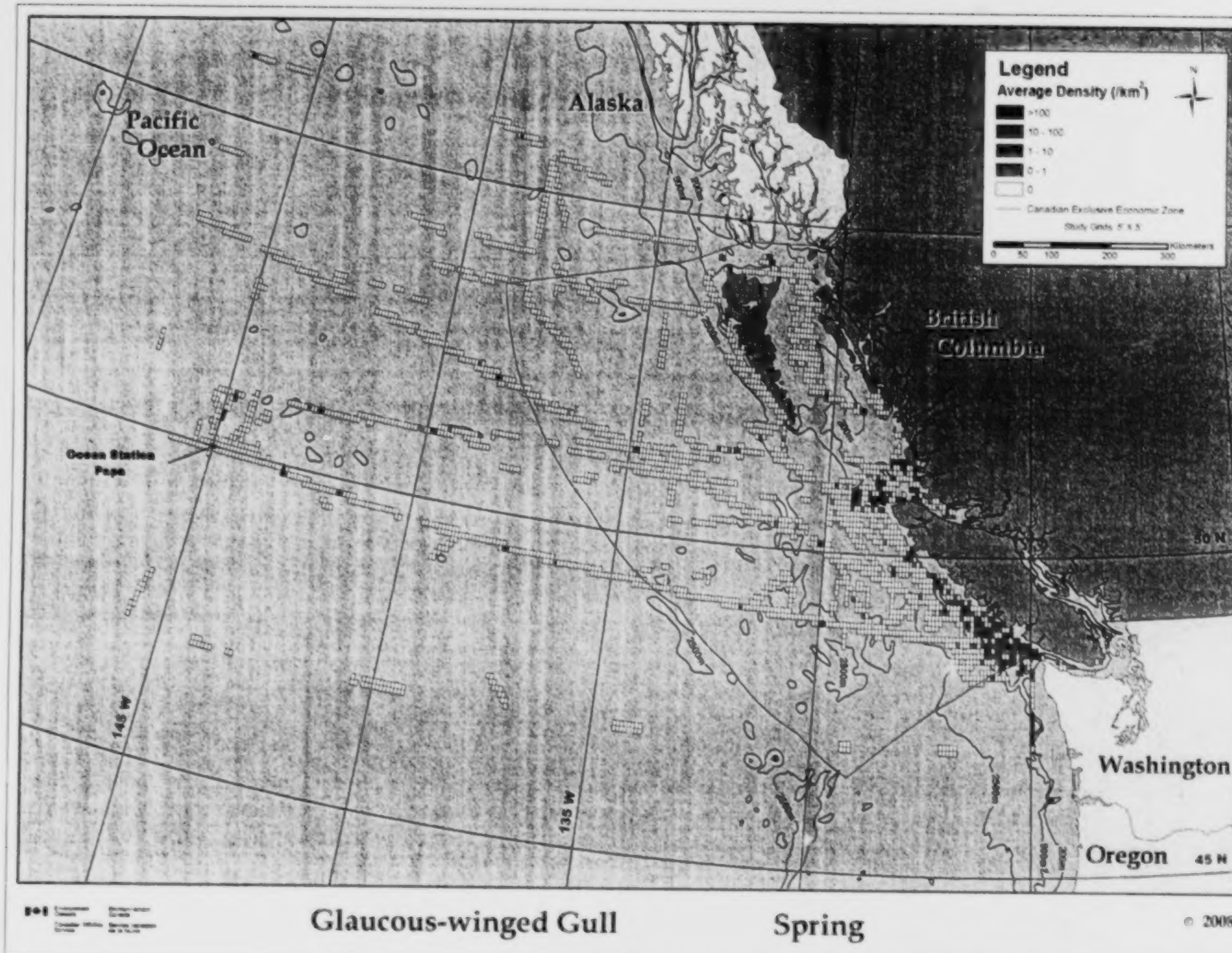

Figure 35A. Seasonal average grid cell densities of Glaucous-winged Gulls.

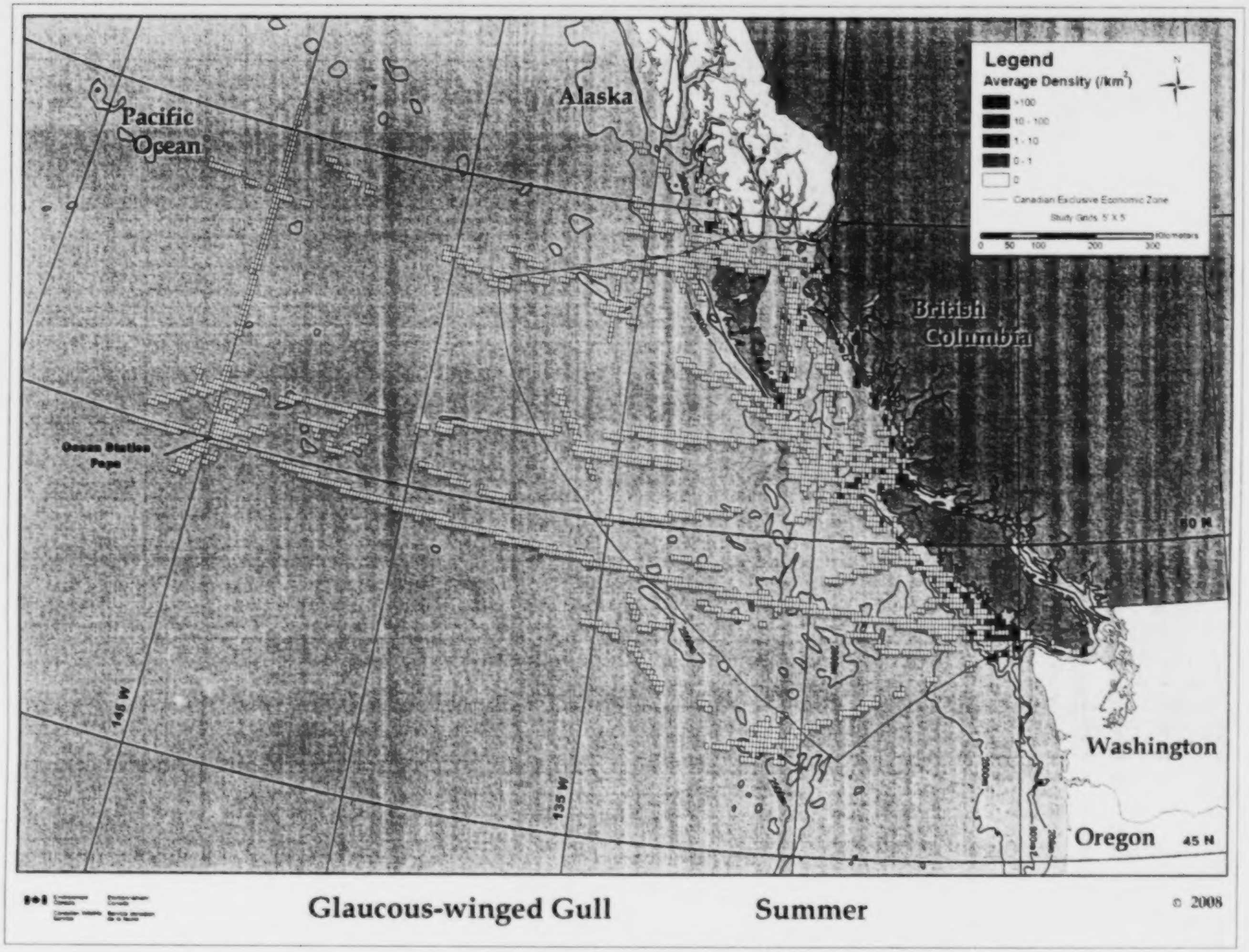

Figure 35B. Seasonal average grid cell densities of Glaucous-winged Gulls.

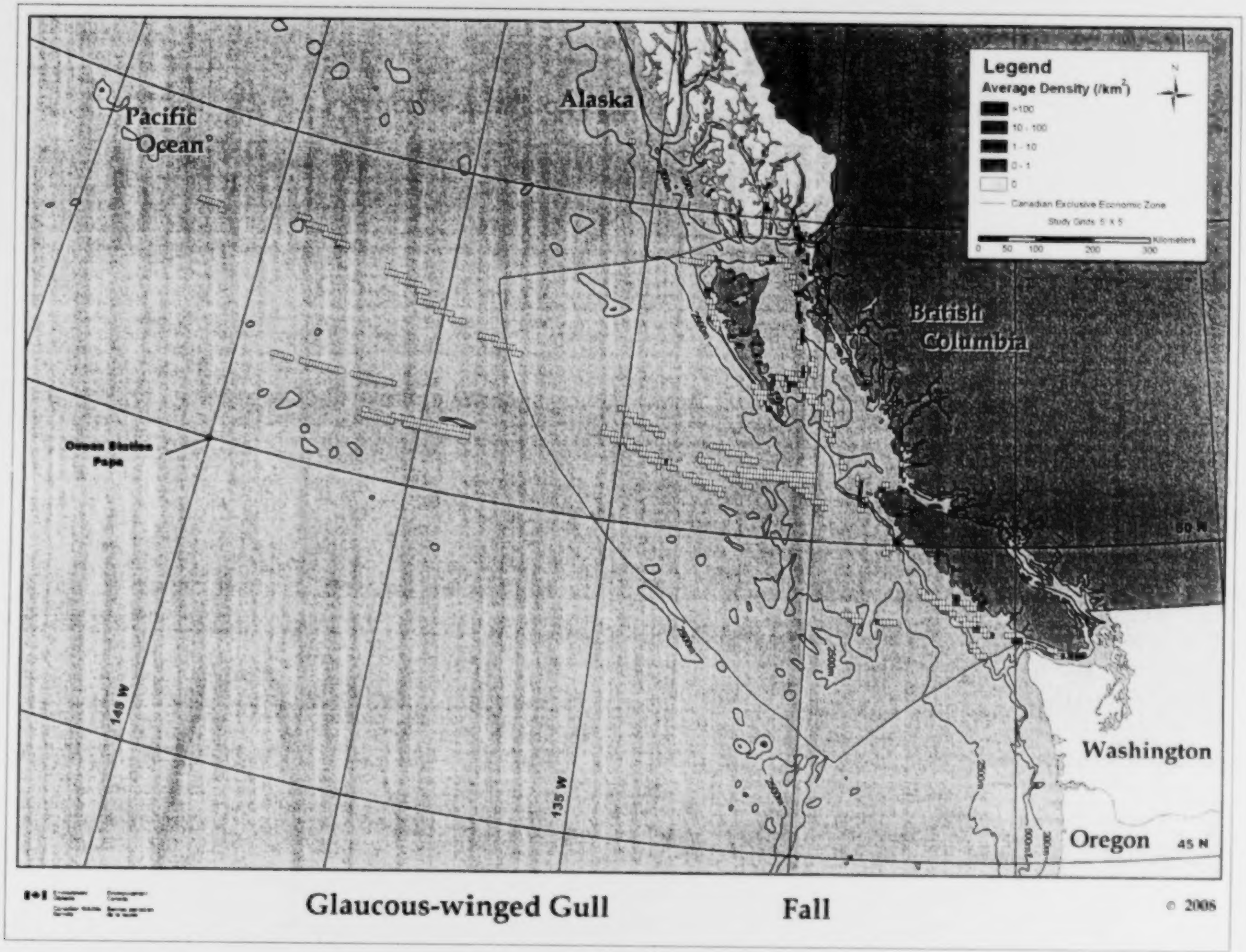

Figure 35C. Seasonal average grid cell densities of Glaucous-winged Gulls.

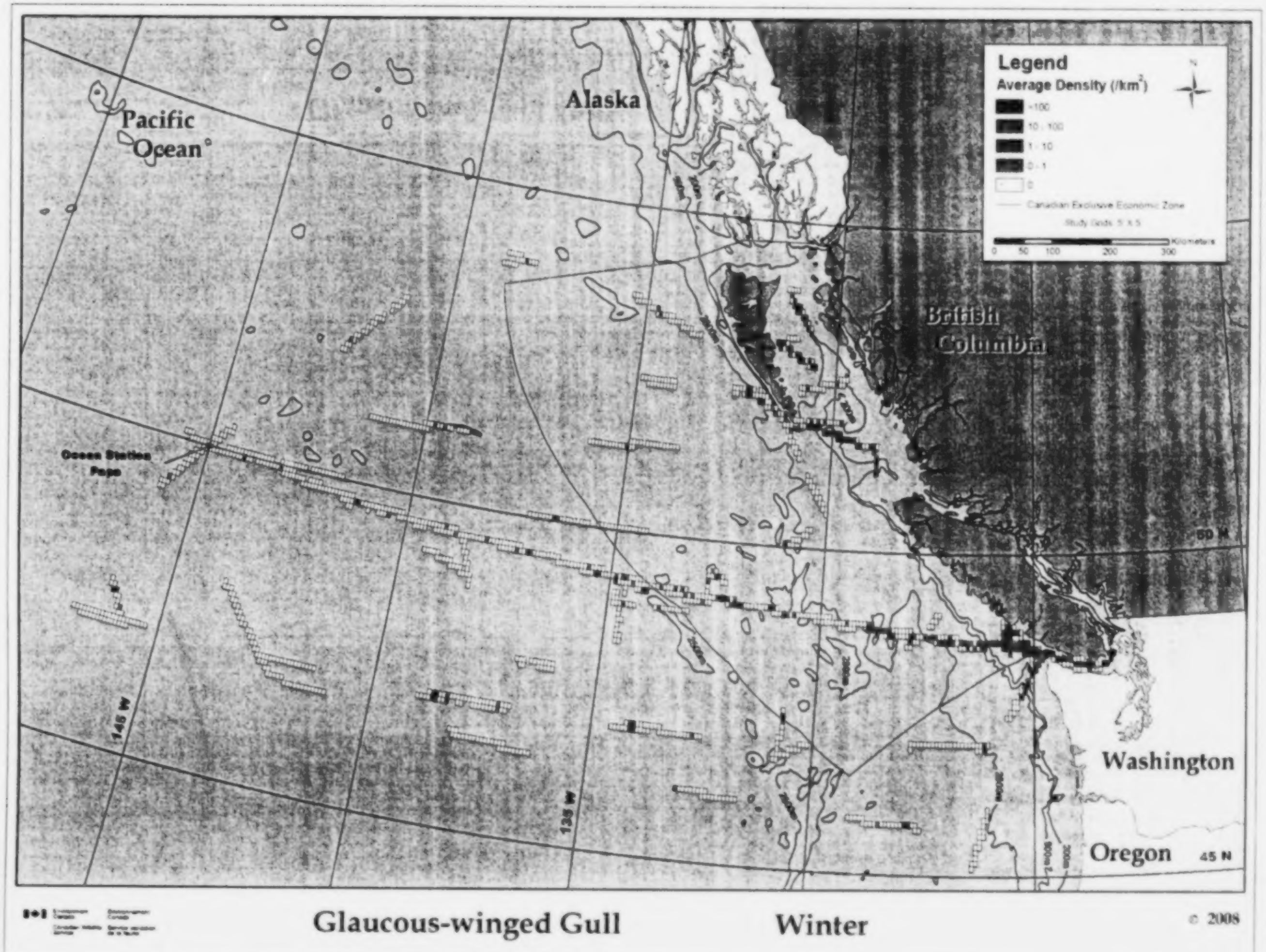

Figure 35D. Seasonal average grid cell densities of Glaucous-winged Gulls.

3.1.8.7 Glaucous-winged Gull *Larus glaucescens*

3.1.8.7.1 Population and Conservation Status

The Glaucous-winged Gull has an estimated global population of 570,000 birds, with approximately 200,000 breeding pairs (Verbeek 1993, Vermeer *et al.* 1993a). They are listed globally as a species of *Least Concern* by the IUCN (BirdLife International 2008) and Kushlan *et al.* (2002) and Milko *et al.* (2003) rank this gull as a species of *Low Conservation Concern* for N America and Canada, respectively.

3.1.8.7.2 Breeding Distribution and Chronology

Glaucous-winged Gulls breed on the Commander Islands (Russia), south along the coast from Cape Romanzof (AK) to northwestern OR (Campbell *et al.* 1990b, Verbeek 1993,). There are roughly 29,000 pairs of Glaucous-winged Gulls nesting in BC, from north of Graham Island (QCI) to as far south as Race Rocks; with close to 50% of the total nesting population located in the Strait of Georgia and about 25% along the west coast of Vancouver Island (Rodway 1991). Arrival at colonies may begin as early as February with most birds having returned by the end of April. Eggs are laid in late May to early June, and fledglings and adults normally depart by mid- to late August (Verbeek 1993).

3.1.8.7.3 Oceanic Distribution and Diet

Glaucous-winged Gulls winter from the northern parts of their breeding range south to Baja California and the Sea of Cortez and northern Japan; they are one of the most ubiquitous species found in northeast N Pacific waters, particularly in winter (Harrison 1983). In the northern GOA, Glaucous-winged Gulls are primarily restricted to shelf regions, where they are common in spring and fall, but uncommon in winter (Day 2006).

Glaucous-winged Gulls feed at or near the water surface while in flight or swimming; they may partially or completely submerge as they pursue prey. At sea, they feed on fish (e.g., capelin, gunnels, Pacific herring, Pacific sandlance, Pacific saury, sculpin, shiner perch, juvenile salmon), herring roe, squid (e.g., *Loligo opalescens*), euphausiids, decapods, offal and carrion (DeGange and Sanger 1986, Verbeek 1993, Gillespie and Westrheim 1997).

3.1.8.7.4 Spatial Distribution and *Average Grid Cell Density* in Study Area

Although we observed Glaucous-winged Gulls most often over the shelf and along the shelfbreak, they were commonly observed in offshore waters, including beyond OSP.

In spring, Glaucous-winged Gulls were encountered in almost every grid cell (of those surveyed) over the continental shelf west and north of Vancouver Island. Maximum *average grid cell*

density was 6.6 birds/km^2. Birds were also widely distributed in offshore areas, as far west as OSP.

The highest Glaucous-winged Gull *average grid cell density* (16.6 birds/km^2) was found during summer, just north of Cape Scott. Glaucous-winged Gulls were also abundant in Juan de Fuca Strait, over Swiftsure Bank, off Cleland Island and west of Dall Island (AK). In marked contrast to the situation in spring, very few Glaucous-winged Gulls were observed beyond the shelf during summer. Many areas with high numbers of Glaucous-winged Gulls were relatively close to the breeding colonies. The same pattern was noted by Morgan *et al.* (1991). Martin and Myres (1969) stated that Glaucous-winged Gulls were seldom seen far from their colonies during the nesting season.

Similar to summer, the vast majority of Glaucous-winged Gulls seen during fall were over the shelf and shelfbreak regions. Densities were relatively low with the maximum *average grid cell density* being 5.8 birds/km^2. Elevated *average grid cell densities* occurred in Clarence Strait, Dixon Entrance, around southern Moresby Island, in Queen Charlotte Strait, and in Juan de Fuca Strait.

Glaucous-winged Gulls were widely dispersed across the study area in winter. They were common over the continental shelf, and regularly observed in offshore waters in low numbers. The highest winter *average grid cell density* (6.7 birds/km^2) was about 15 km south of Cape Beale.

Glaucous-winged Gulls are present all year long in BC and WA, and are common to very abundant residents on marine waters and shorelines (Campbell *et al.* 1990b, Wahl *et al.* 2005).

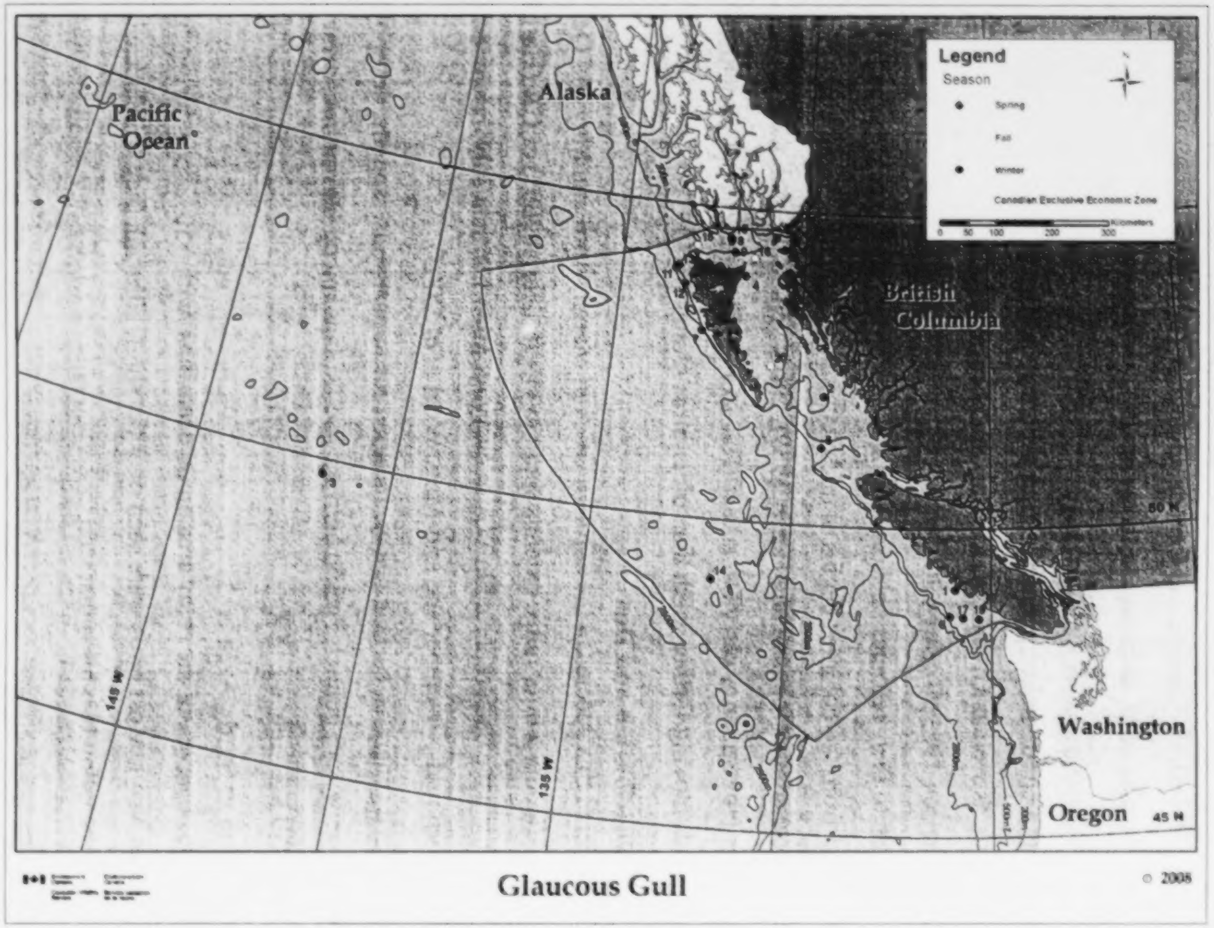

Figure 36. Locations where Glaucous Gulls have been observed.

See Appendix 1 for details.

3.1.8.8 Glaucous Gull *Larus hyperboreus*

3.1.8.8.1 Population and Conservation Status

Global population estimates of Glaucous Gulls are as high as 2,000,000 individuals; consequently the IUCN considers it globally as a species of *Least Concern* (BirdLife International 2008). In both N America and Canada, Glaucous Gulls are classified as *Not Currently at Risk* (Kushlan *et al.* 2002 and Milko *et al.* 2003, respectively).

3.1.8.8.2 Breeding Distribution and Chronology

The Glaucous Gull is a circumpolar species, nesting primarily north of the Arctic Circle in AK, YT, NT and Nunavut, as well as Greenland, Iceland, Spitsbergin, and northern Russia to Wrangel Island (Harrison 1983, Gilchrist 2001).

Glaucous Gulls return to their colonies between Mar and early May, and eggs are usually laid by early June. Dispersal from the colonies begins in mid-September, although young birds may remain later than most adults (Johnson and Herter 1989). Birds generally reach their southern wintering grounds in November or early December (Harrison 1983, Gilchrist 2001), with first- and second-year birds moving farther south than older birds (Johnston 1955).

3.1.8.8.3 Oceanic Distribution and Diet

Day (2006) encountered this species in the northern GOA in March, April and May and October. In the eastern N Pacific, the winter range extends south to OR (Gilchrist 2001) or CA (Harrison 1983). Glaucous Gulls have been reported in WA in every month other than July; however, most birds are seen between mid-November and mid-May (Wahl *et al.* 2005).

The Glaucous Gull is a generalist surface feeder, foraging for euphausiids, isopods, decapods, fish (e.g., capelin, Arctic cod, gunnel, Pacific herring, Pacific sandlance), herring roe, offal and carrion (Gilchrist 2001).

3.1.8.8.4 Distribution in Study Area

Glaucous Gulls were observed in the study area on 20 occasions, with >50% seen during spring (especially April and May). Most birds were seen over the shelf, although they were occasionally seen well offshore, including two birds that were observed almost 1,100 km west of Nootka Island.

Glaucous Gulls were not observed in the study area during summer. The earliest fall record was 16 September. All fall observations were from the shelf north or east of the QCI.

During winter, Glaucous Gulls were seen off southwest Vancouver Island, in Hecate Strait and west of the QCI from late January to almost the middle of March.

Campbell *et al.* (1990b) stated that Glaucous Gulls occur in BC throughout the year and are most numerous in winter, with almost 70% of their records falling between December and the end of March.

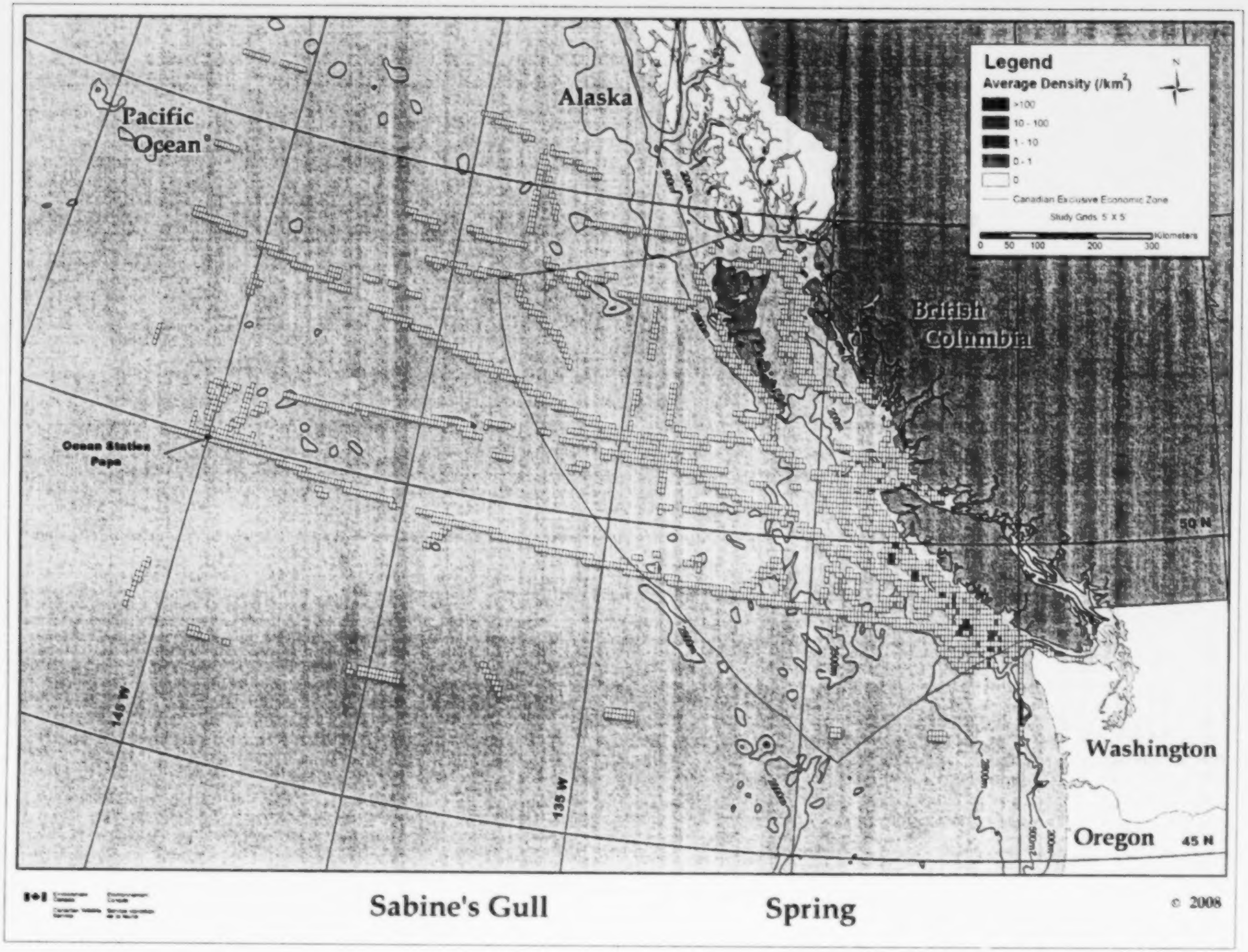

Figure 37A. Seasonal average grid cell densities of Sabine's Gulls.

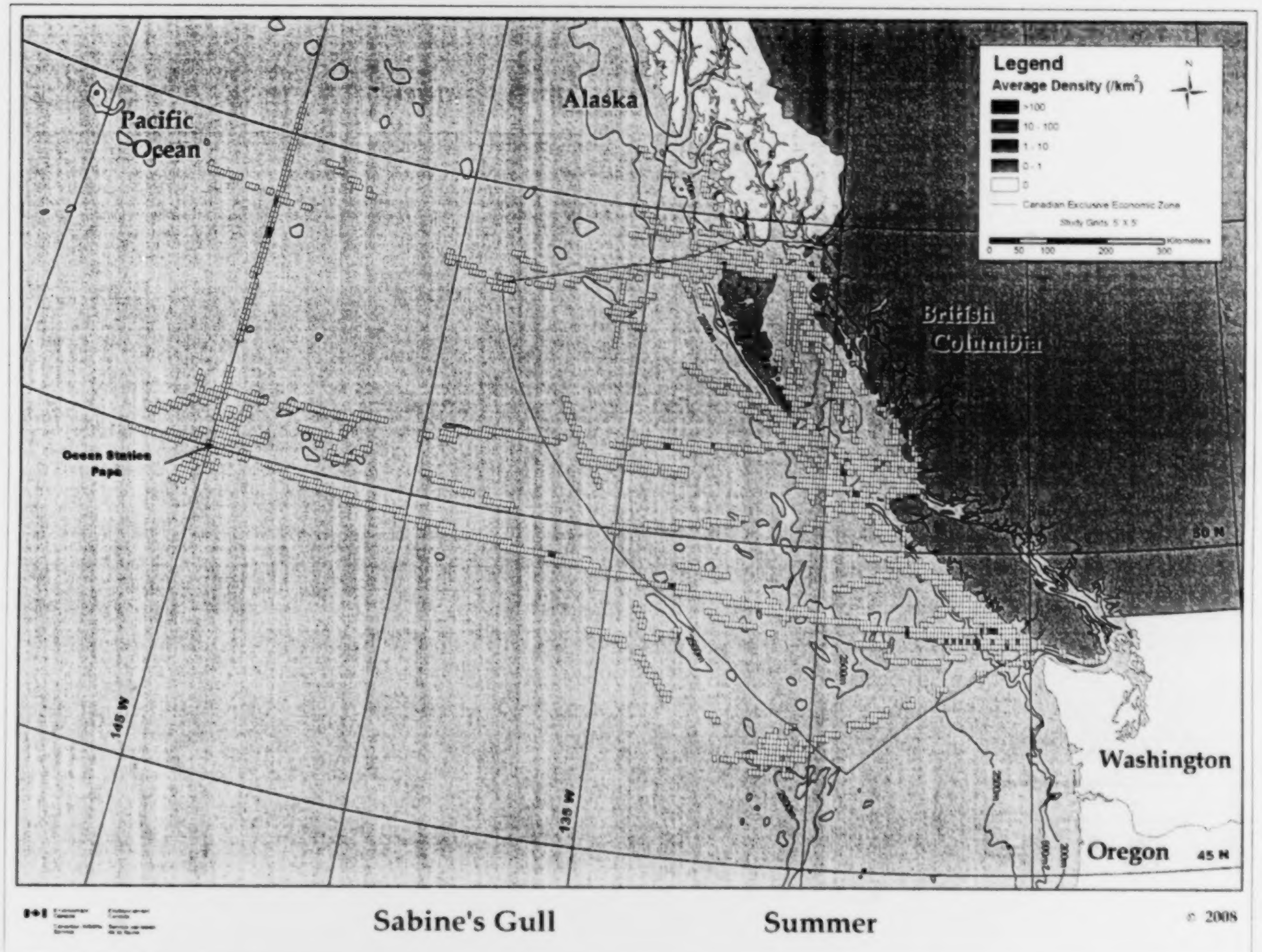

Figure 37B. Seasonal average grid cell densities of Sabine's Gulls.

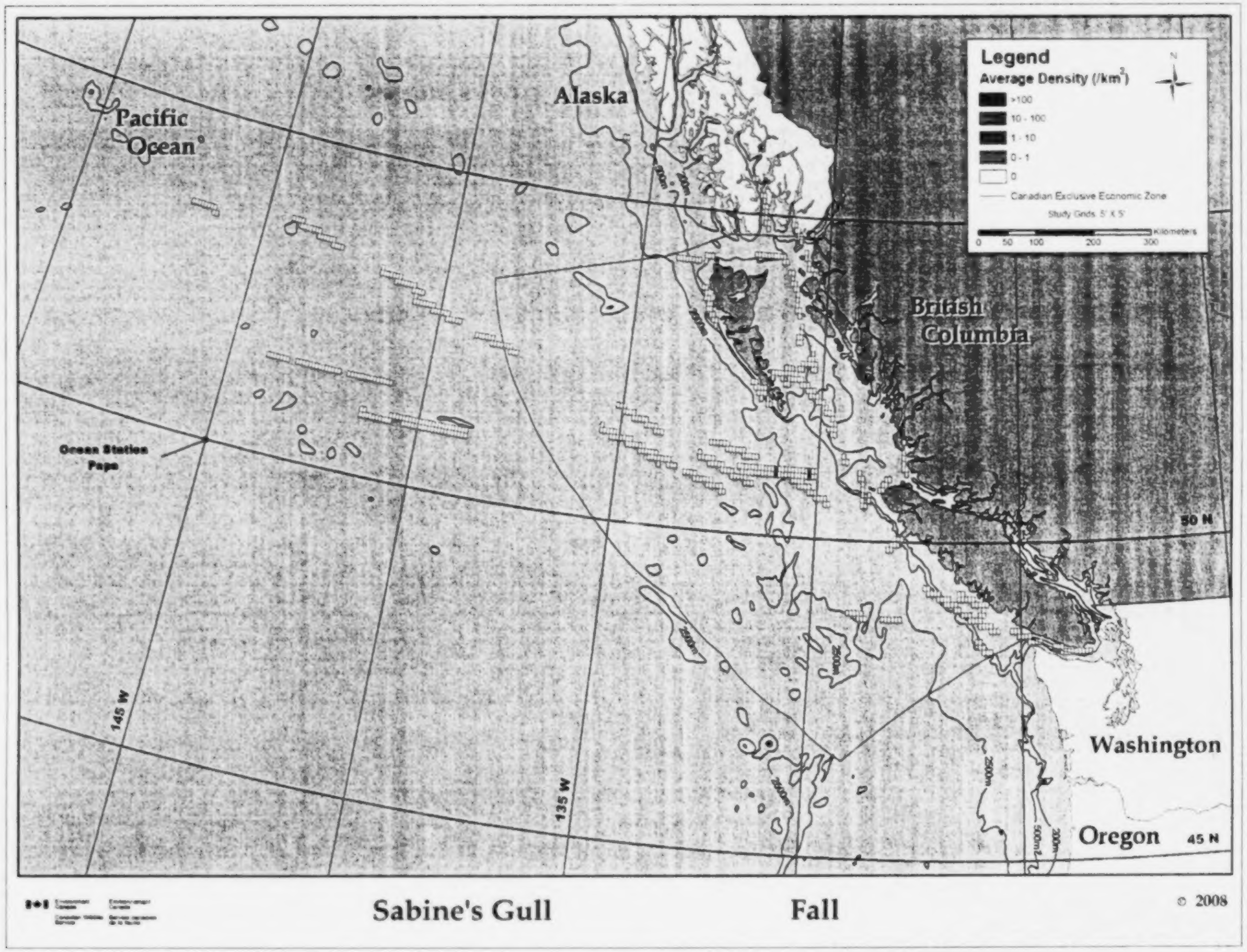

Figure 37C. Seasonal average grid cell densities of Sabine's Gulls.

3.1.8.9 Sabine's Gull *Xema sabini*

3.1.8.9.1 Population and Conservation Status

Sabine's Gulls are circumpolar breeders with an estimated population of 700,000 individuals (BirdLife International 2008); approximately 50% breed in Canada (Milko *et al.* 2003). Globally, Sabine's Gull is listed as a species of *Least Concern* by the IUCN (BirdLife International 2008); and a species of *Low Conservation Concern* for N America and Canada (Kushlan *et al.* 2002, Milko *et al.* 2003, respectively).

3.1.8.9.2 Breeding Distribution and Chronology

Sabine's Gulls nest in western and northern AK, the Canadian Arctic, including the northwestern Mackenzie District, the central Arctic islands, and northern Hudson Bay; as well as in Greenland, Spitsbergen and Russia (Harrison 1983. Day *et al.* 2001). The northbound migration from their tropical and sub-tropical wintering areas begins as early as February and may continue through May (Day *et al.* 2001). Sabine's Gulls arrive on the breeding grounds from early May to early June, and eggs are laid from late May through June (Day *et al.* 2001). Failed breeders may abandon the colonies in July; most birds have departed by mid-August (Harrison 1983, Day *et al.* 2001).

3.1.8.9.3 Oceanic Distribution and Diet

Briggs *et al.* (1987) noted that although they were found in nearshore waters in CA, Sabine's Gulls were most numerous beyond the shelfbreak. Sabine's Gulls that migrate along the west coast of Canada overwinter in coastal upwelling zones from northern MX to Peru or northern Chile; however, the southern extent of the wintering area is poorly understood. They are occasionally recorded in winter off BC, WA, OR and CA (Day *et al.* 2001).

Day (2006) rarely encountered Sabine's Gulls in the northern GOA, with only May records. Off WA, Sabine's Gulls have been seen in February through to early June and from early July to approximately mid-November; observations of this gull in inland marine waters are less frequent, but extend the period to mid-December (Wahl *et al.* 2005).

The diet of Sabine's Gulls during the migratory period is poorly known but it is believed to consist mostly of zooplankton (e.g., *Thysanoessa inermis*, *T. raschii*), small fish (e.g., Pacific herring), jellyfish and occasionally carrion and offal (Day *et al.* 2001).

3.1.8.9.4 Spatial Distribution and *Average Grid Cell Density* in Study Area

In the study area Sabine's Gulls were strongly associated with the shelfbreak; although some birds were encountered offshore during summer and fall. The highest Sabine's Gull *average grid cell density* (75.0 birds/km^2) during spring occurred along the shelfbreak west of Cape Beale; this was the result of a large flock (210 birds) observed on 11 May 2000. Records of this species were restricted almost entirely to the southern portion of the continental shelf/upper slope sub-region of the study area; the farthest north a bird was seen was over Cook Bank. All spring records of Sabine's Gulls were between 1 May and 10 June.

During summer, Sabine's Gulls were more widely distributed, although most sightings were still concentrated off southwest Vancouver Island. Birds were seen up to approximately 700 km from land. Densities were generally lower in summer with the highest *average grid cell density* being 1.9 birds/km^2. Although Sabine's Gulls were observed in mid-July, they were encountered primarily from late August to early September.

There were only two observations of Sabine's Gulls during fall; both on 18 September 2000, west of Cape Scott. Morgan *et al.* (1991) reported that the latest a Sabine's Gull was observed in BC waters was on 29 October 1984. We did not observe Sabine's Gulls in the study area during winter.

Campbell *et al.* (1990b) noted that Sabine's Gulls have been seen in BC in every month other than January; of which almost 33% of all records were in May and June and >52% during August through October.

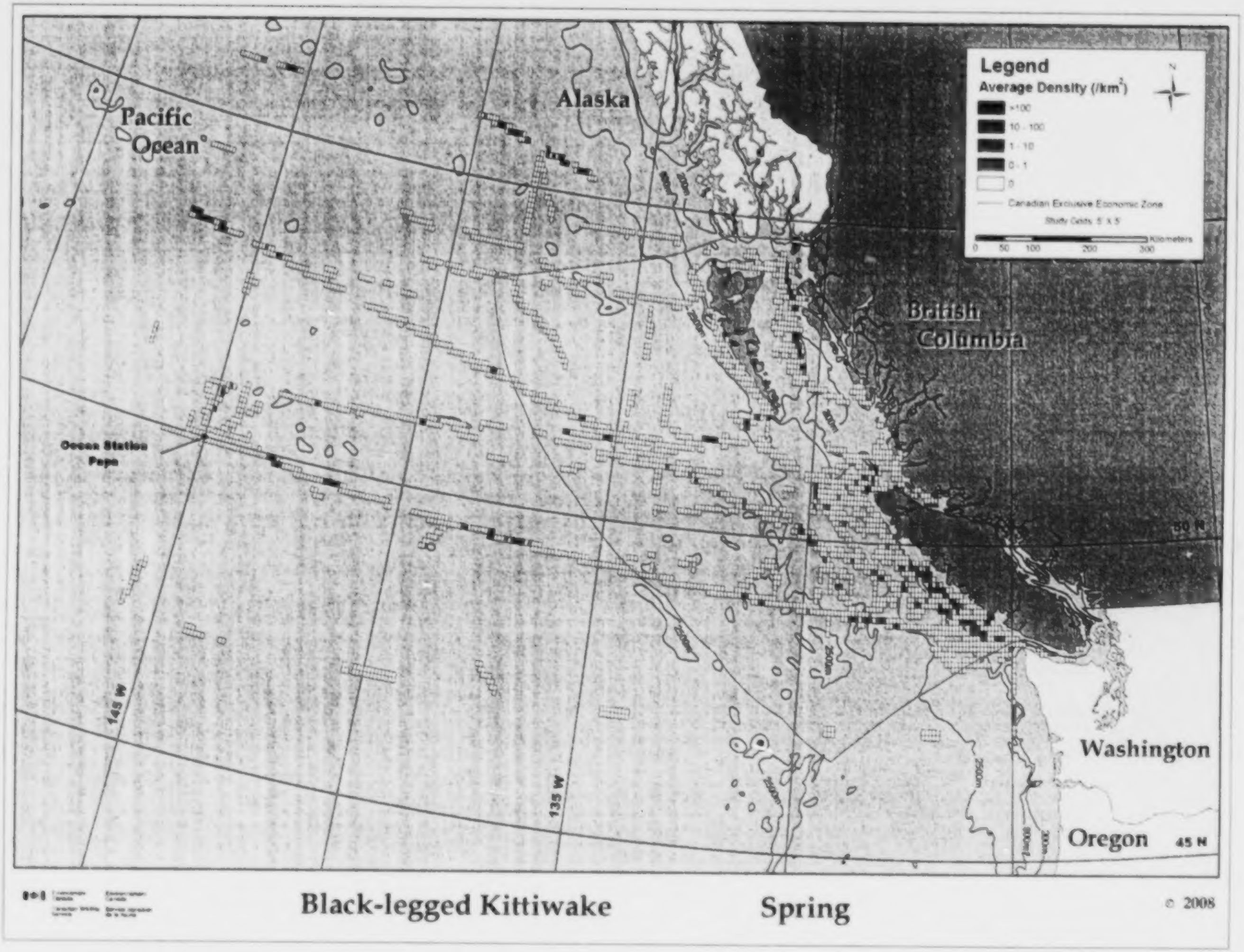

Figure 38A. Seasonal average grid cell densities of Black-legged Kittiwakes.

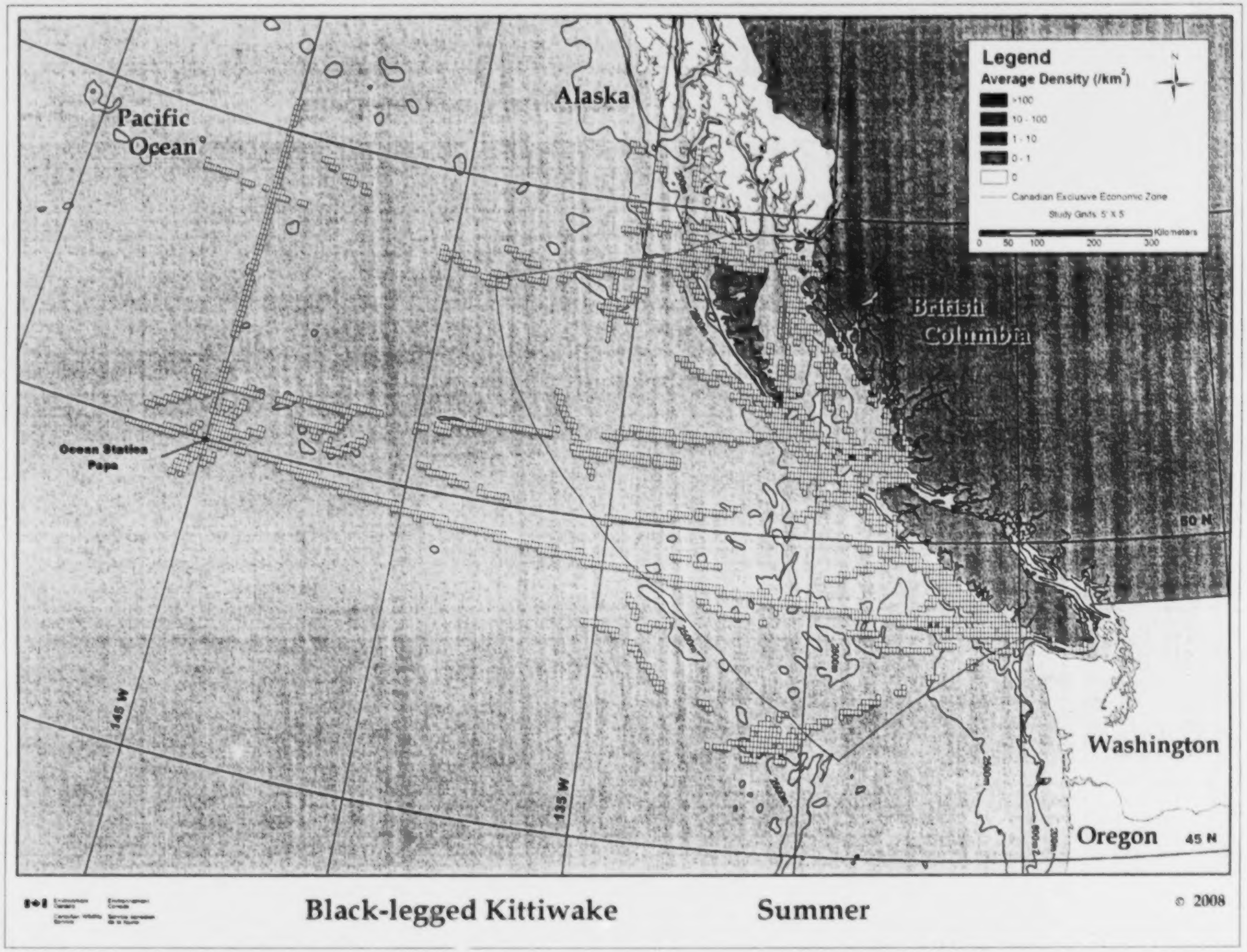

Figure 38B. Seasonal average grid cell densities of Black-legged Kittiwakes.

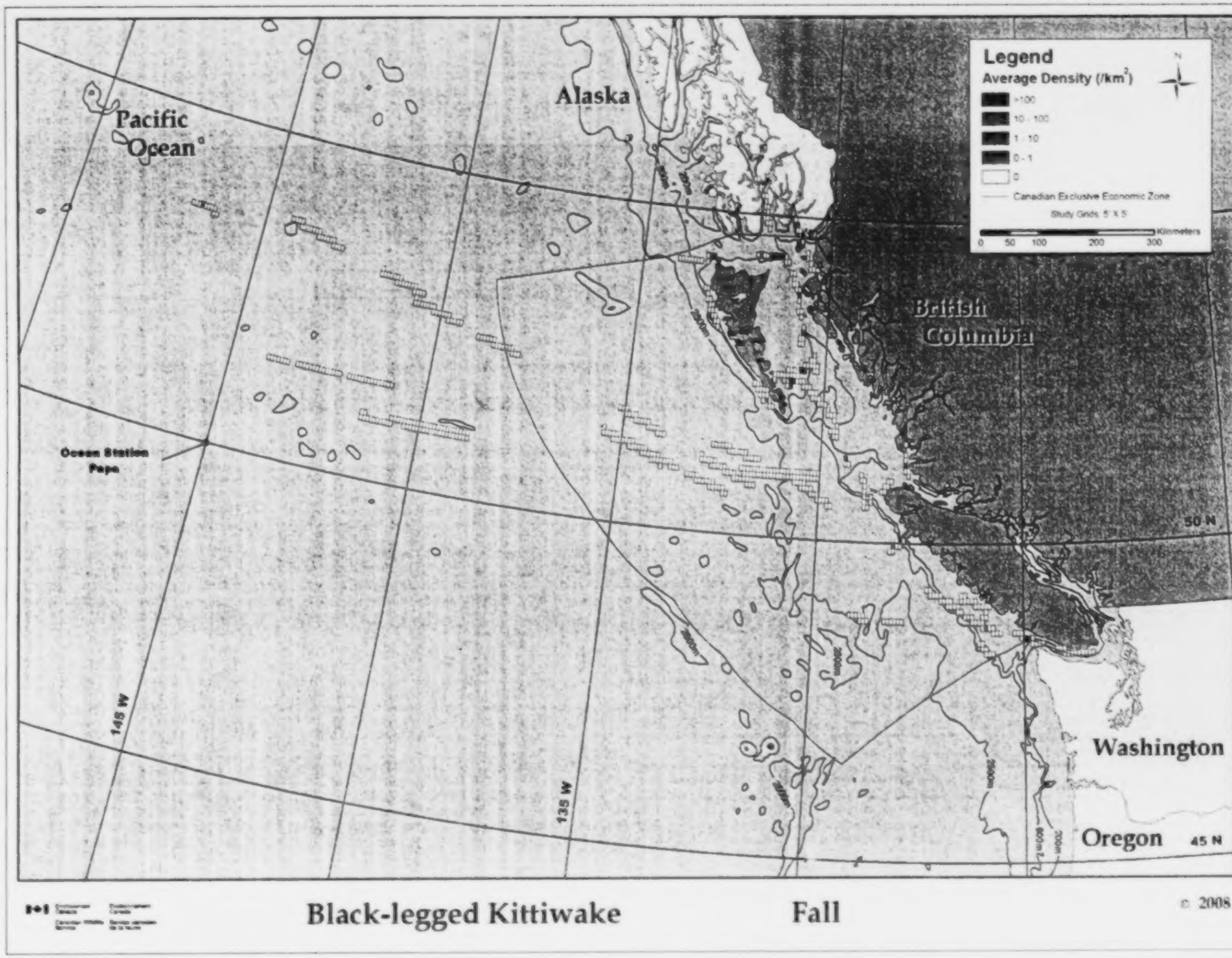

Figure 38C. Seasonal average grid cell densities of Black-legged Kittiwakes.

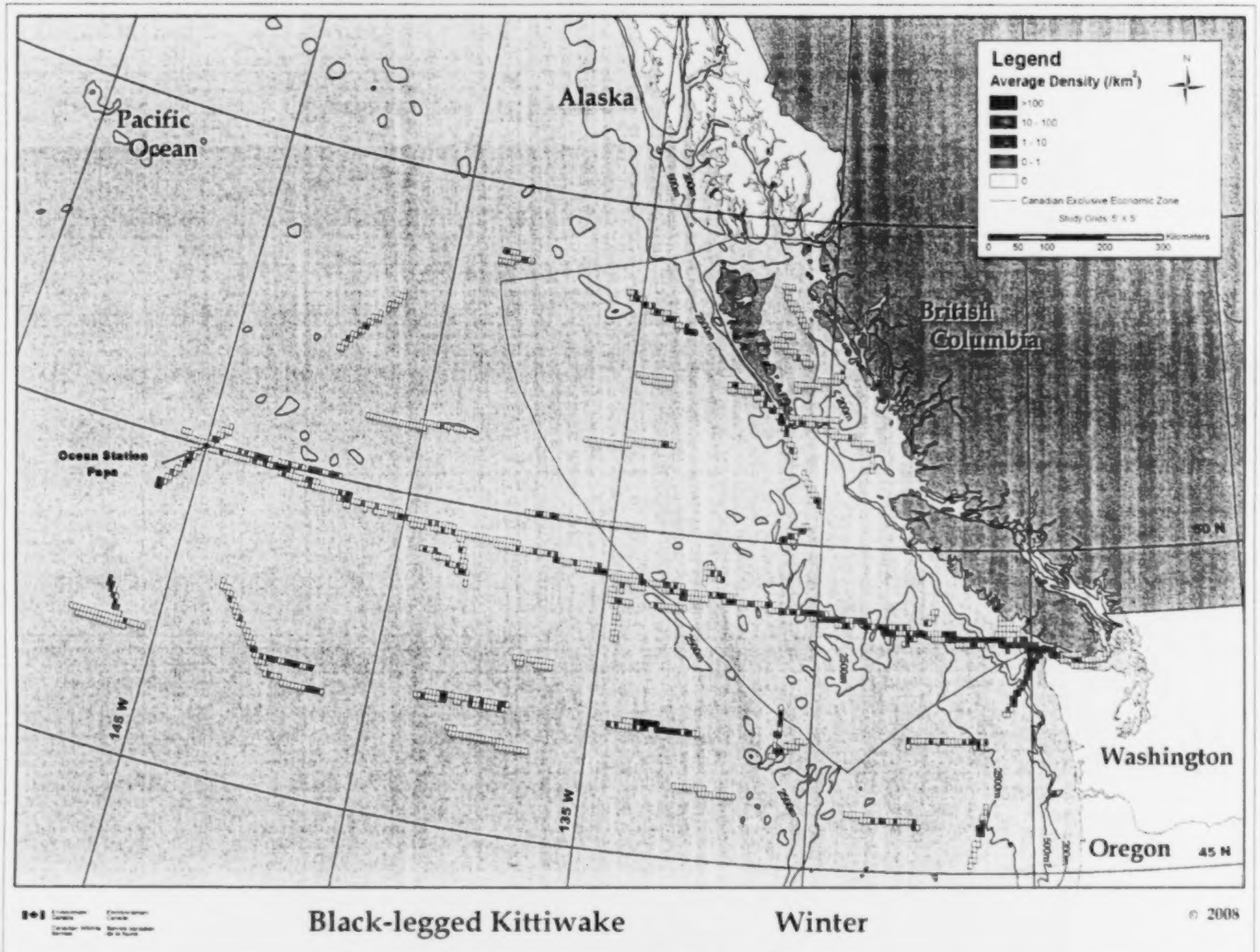

Figure 38D. Seasonal average grid cell densities of Black-legged Kittiwakes.

3.1.8.10 Black-legged Kittiwake *Rissa tridactyla*

3.1.8.10.1 Population and Conservation Status

The Black-legged Kittiwake has a population estimated at 18 million individuals; with an estimated 2.6 million Black-legged Kittiwakes breed in the N Pacific and adjacent areas (Hatch *et al.* 1993, BirdLife International 2008). It is globally ranked by the IUCN as a species of *Least Concern* (BirdLife International 2008) and is considered *Not Currently at Risk* in N America and Canada (Kushlan *et al.* 2002, Milko *et al.* 2003).

3.1.8.10.2 Breeding Distribution and Chronology

Black-legged Kittiwake breeding distribution is nearly circumpolar, from northeastern Siberia to Kamchatka and the Commander Islands, the Bering Sea and the Aleutians, along the Canadian Arctic coast, QC, northern NL, Nova Scotia (NS), and in Greenland, Iceland, Spitsbergen, Jan Mayen, the Faeroe Islands, Norway, the British Isles and northern France (Harrison 1983, Baird 1994). Until recently it was thought that in western N America, Black-legged Kittiwakes nested exclusively in AK, with over 50% of colonies in the GOA (Baird 1994). However, in 1997 three Black-legged Kittiwake nests were found on Holland Rock, Chatham Sound (Campbell *et al.* 2001).

Depending on the colony location, breeding may commence as early as the beginning of April. Eggs are laid between May and July, and fledging takes place between late July and the end of August (Harrison 1983, Baird 1994).

3.1.8.10.3 Oceanic Distribution and Diet

In the N Pacific, Black-legged Kittiwakes overwinter from the edge of the sea ice in the Bering Sea, south to Japan and Baja California (Harrison 1983, Briggs *et al.* 1987, Baird 1994). Day (2006) found that kittiwakes were primarily a coastal species in the northern GOA, but were less common inshore during December and March, suggesting inshore-offshore seasonal movements. Wahl *et al.* (2005) reported that Black-legged Kittiwakes are seen throughout the year in WA waters, being a common migrant and winter resident offshore and along the outer coast, and locally uncommon to common summer coastal resident. They are considered an abundant spring and fall migrant in offshore waters but uncommon in nearshore waters, irregularly abundant to very abundant in outer coastal areas during summer, and rare (inshore waters) to probably common in offshore areas during winter (Campbell *et al.* 1990b).

Major prey items of Black-legged Kittiwakes include euphausiids (e.g., *Thysanoessa inermis*), gammarid amphipods, jellyfish, small squid, and fish (e.g., capelin, myctophids, Pacific herring, Pacific sandlance, Pollock, sculpin) that are captured up to 1 m below the water's surface (Hunt *et al.* 1981, Harrison 1984, DeGange and Sanger 1986, Vermeer 1992, Baird 1994, Gillespie and Westrheim 1997).

3.1.8.10.4 Spatial Distribution and *Average Grid Cell Density* in Study Area

Black-legged Kittiwakes were found in the study area throughout the year; however, they were only common during winter and spring. They were observed over the shelf in all seasons and far offshore particularly in winter and spring.

This species was observed in all spring months but most observations were in March and April. During spring the highest *average grid cell density* of Black-legged Kittiwakes (16.3 birds/km^2) was in Hecate Strait. Highest average densities were found primarily over the shelf although; elevated *average grid cell densities* were also located >125 km southwest of Moresby Island, as well in Alaskan waters and international waters northwest of OSP.

Very few Black-legged Kittiwakes were observed during summer; those encountered were likely non-breeders.

The fall distribution of Black-legged Kittiwakes was primarily in the northern shelf/upper slope sub-region. Approximately 66% of all kittiwakes seen at this time of the year were encountered in Hecate Strait or Dixon Entrance. Most sightings were of one or two birds; the largest flock was of 44 birds, seen over La Perouse Bank on 2 October 2004.

Black-legged Kittiwakes were most dispersed (albeit at low densities) during winter. They were very common over La Perouse and Swiftsure Banks, and off the northwest coast of WA. The highest *average grid cell density* in the offshore sub-regions was 7.1 birds/km^2; most were <3.5 birds/km^2.

The Black-legged Kittiwake has been observed in BC in every month (Campbell *et al.* 1990b).

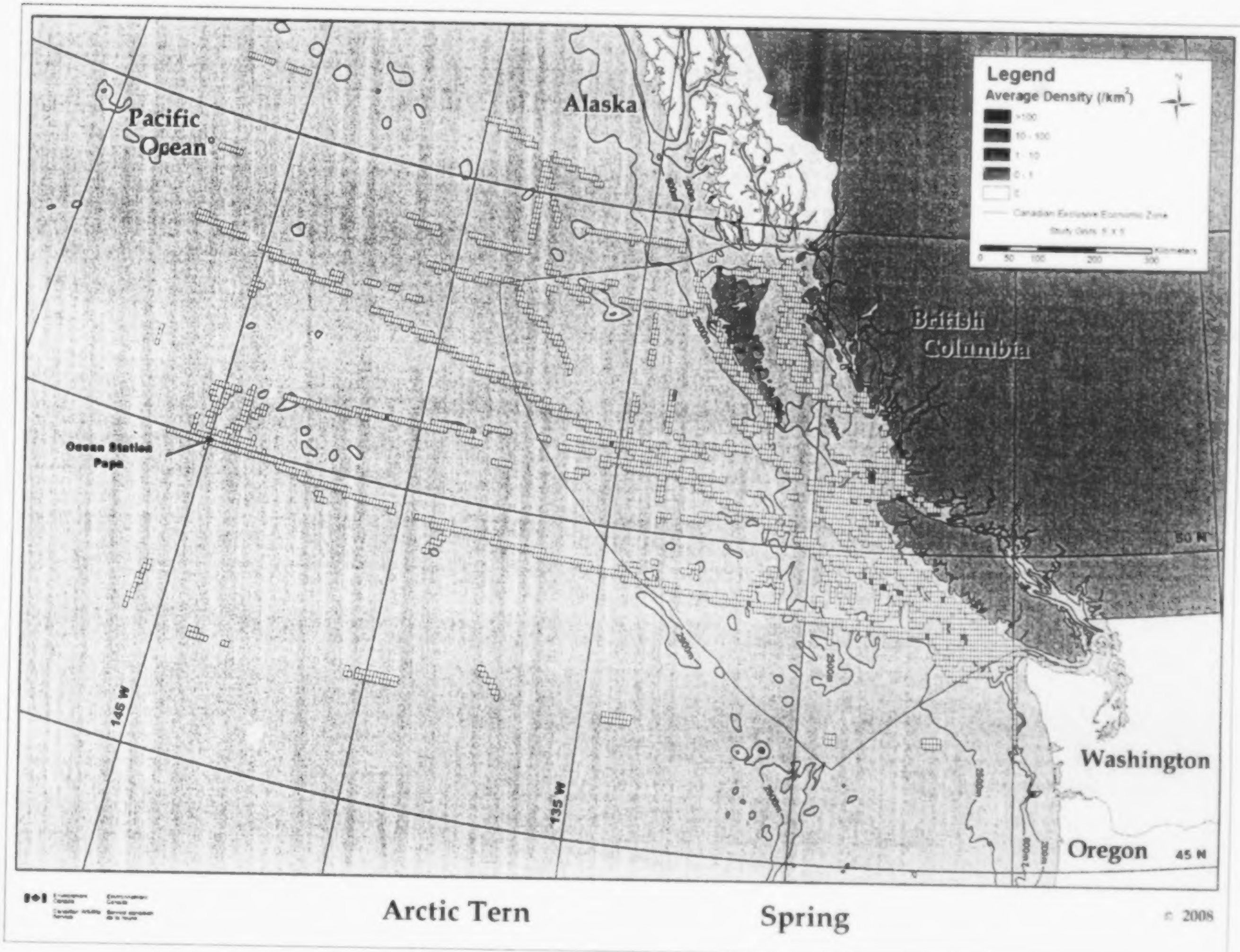

Figure 39A. Seasonal average grid cell densities of Arctic Terns.

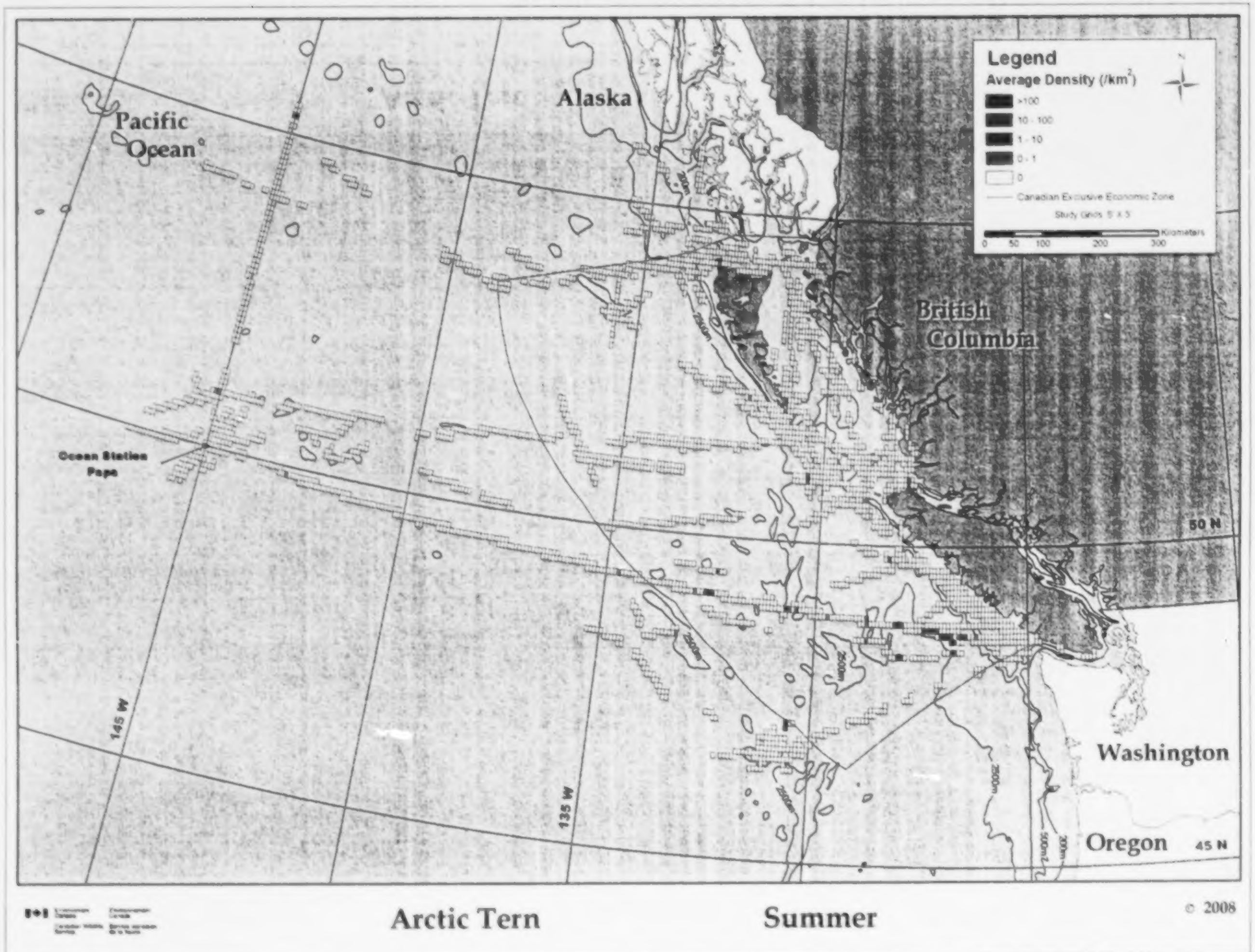

Figure 39B. Seasonal average grid cell densities of Arctic Terns.

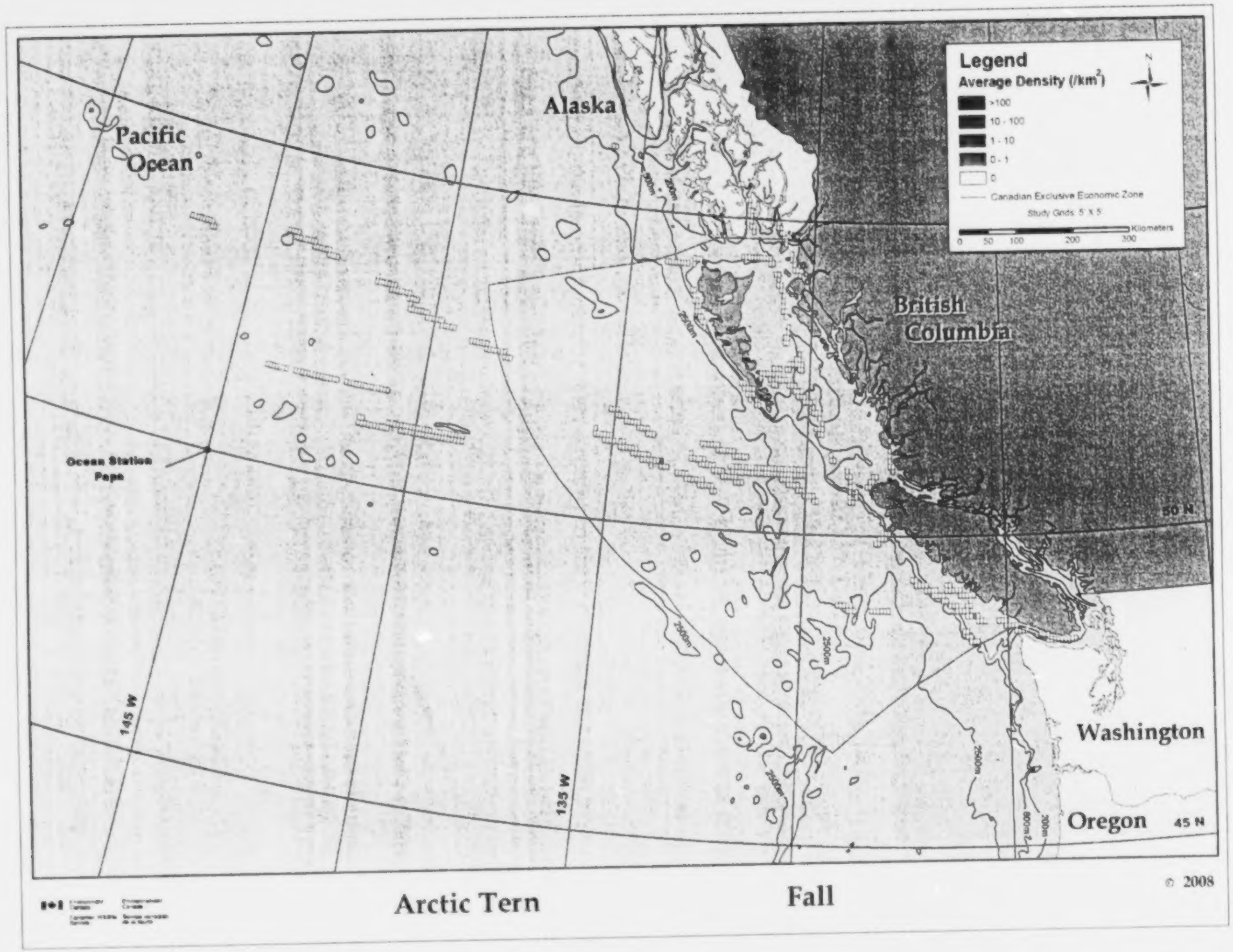

Figure 39C. Seasonal average grid cell densities of Arctic Terns.

Arctic Tern (*Sterna paradisaea*).
© Cameron Eckert.

3.1.8.11 Arctic Tern *Sterna paradisaea*

3.1.8.11.1 Population and Conservation Status

The Arctic Tern has a worldwide population of approximately one million birds and is listed by the IUCN as a species of *Least Concern* (BirdLife International 2008). Kushlan *et al*. (2002) list the Arctic Tern as a species of *High Conservation Concern* for N America whereas Milko *et al.* (2003) rank it as a species of *Moderate Conservation Concern* for Canada.

3.1.8.11.2 Breeding Distribution and Chronology

Arctic Terns are circumpolar breeders, nesting near water in Arctic and sub-Arctic regions of N America in AK and Canada, south to BC on the west coast, and Massachusetts on the east coast. They also breed in Greenland, Iceland, the Faeroes, Britain, Ireland, France, Scandinavia, Spitsbergen and northern Russia to the Bering Sea (Harrison 1983). In the N Pacific, the majority of the estimated 30,000 coastal breeding pairs nest in AK (Clapp *et al.* 1993). The Arctic Tern breeds in northwestern BC from near the Tatshenshini River east to Atlin Lake, south to the Spatsizi Plateau and Stewart (Campbell *et al.* 1990b). A small colony was discovered in 1977 near Everett WA (Manuwal *et al.* 1979); however, the current status and the future of the colony are uncertain (Wahl *et al*. 2005).

Depending on the location, Arctic Terns return to their colonies between mid-April and mid-May, eggs are laid from late May to July, and dispersal begins in August (Harrison 1983, Hatch 2002).

3.1.8.11.3 Oceanic Distribution and Diet

Arctic Terns generally overwinter in Antarctic and sub-Antarctic waters (Clapp *et al.* 1993, Hatch 2002). Migration occurs across the breadth of the Pacific Ocean (Wahl *et al.* 1989); whereas Briggs *et al.* (1987) noted that Arctic Terns off CA concentrated over the continental slope, primarily outside of the upwelling zone.

Arctic Terns feed mainly at or near the water surface by plunge-diving for small fish (e.g., capelin, Pacific herring, Pacific sandlance), euphausiids (e.g., *Thysanoessa inermis*) and amphipods (DeGange and Sanger 1986, Hatch 2002).

3.1.8.11.4 Spatial Distribution and *Average Grid Cell Density* in Study Area

Within the study area, Arctic Terns were found at low densities primarily during their north and southbound migration. They occurred both on the shelf as well as offshore. Our earliest records of Arctic Terns were two observations (one of a single bird and one of four birds) on 11 May

near the shelfbreak between Nootka Island and Barkley Sound. The majority of spring sightings of Arctic Tern were during the first half of June. Densities were low, with the highest *average grid cell density* being 1.6 birds/km^2. Most spring observations of this tern species occurred at or just seaward of the shelfbreak; there were a few scattered sightings farther offshore to approximately 605 km from the nearest land.

There were few sightings of Arctic Tern in July. Most summer observations, likely of southbound migrants, occurred in the last half of August and early September. Maximum summertime *average grid cell density* was 1.9 birds/km^2, but most cells had *average grid cell densities* <1.0 bird/km^2. There were very few observations of Arctic Terns from the shelf; most sightings were along Line P seaward of the shelfbreak out to west of 145° W (approximately 870 km from land).

There were two sightings of Arctic Tern during fall; both of single birds in early October. One sighting was from La Perouse Bank and the other approximately 215 km southwest of Cape St. James.

There were no records of Arctic Tern during winter.

Arctic Terns have been reported from coastal BC between 27 April and 14 October; they are considered rare during spring and uncommon to fairly common during fall (Campbell *et al.* 1990b).

3.1.9 Alcids

Tufted Puffin (*Fratercula cirrhata*).
© Rob Tizard.

Alcids are small to medium-sized seabirds highly adapted for underwater 'flight' in pursuit of prey; having traded aerial dexterity for underwater manoeuvrability. They have relatively large, chunky bodies in relation to small wings, making their flight powerful and fast. Alcids are confined to the N Hemisphere and their breeding distribution is determined by the location of suitable nesting islands and proximity to rich foraging grounds. Most alcids nest on the ground, in rock crevices, tunnels, or on cliff faces. Islands provide two important advantages: refuge from terrestrial predators that might otherwise attack while they are nesting on the ground; and proximity to marine foraging locations. Thus, the distribution of suitable nesting islands to a large extent drives the at-sea distribution of alcids, particularly during spring and summer (Gaston and Jones 1998). At a finer resolution, the marine distribution of alcids during the nesting season may in part be determined by bathymetric or oceanographic features such as banks, eddies, upwelling and the mixing of currents (Gaston and Jones 1998).

Alcids were widespread throughout the study area. Seven common species (Common Murre, Pigeon Guillemot, Marbled Murrelet, Ancient Murrelet, Cassin's Auklet, Rhinoceros Auklet and Tufted Puffin), and four uncommon to rare species (Thick-billed Murre, Xantus's Murrelet, Parakeet Auklet and Horned Puffin) were observed.

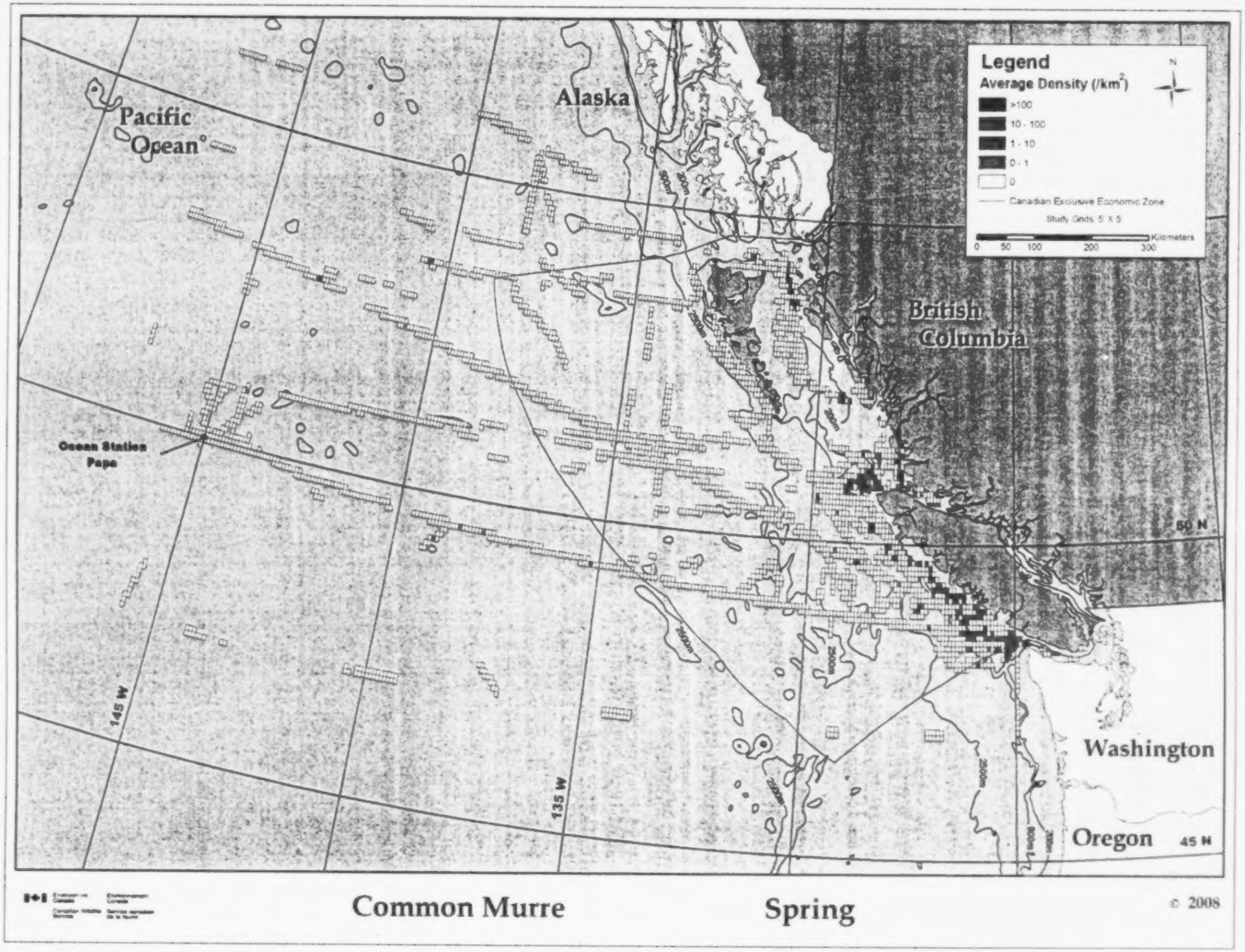

Figure 40A. Seasonal average grid cell densities of Common Murres.

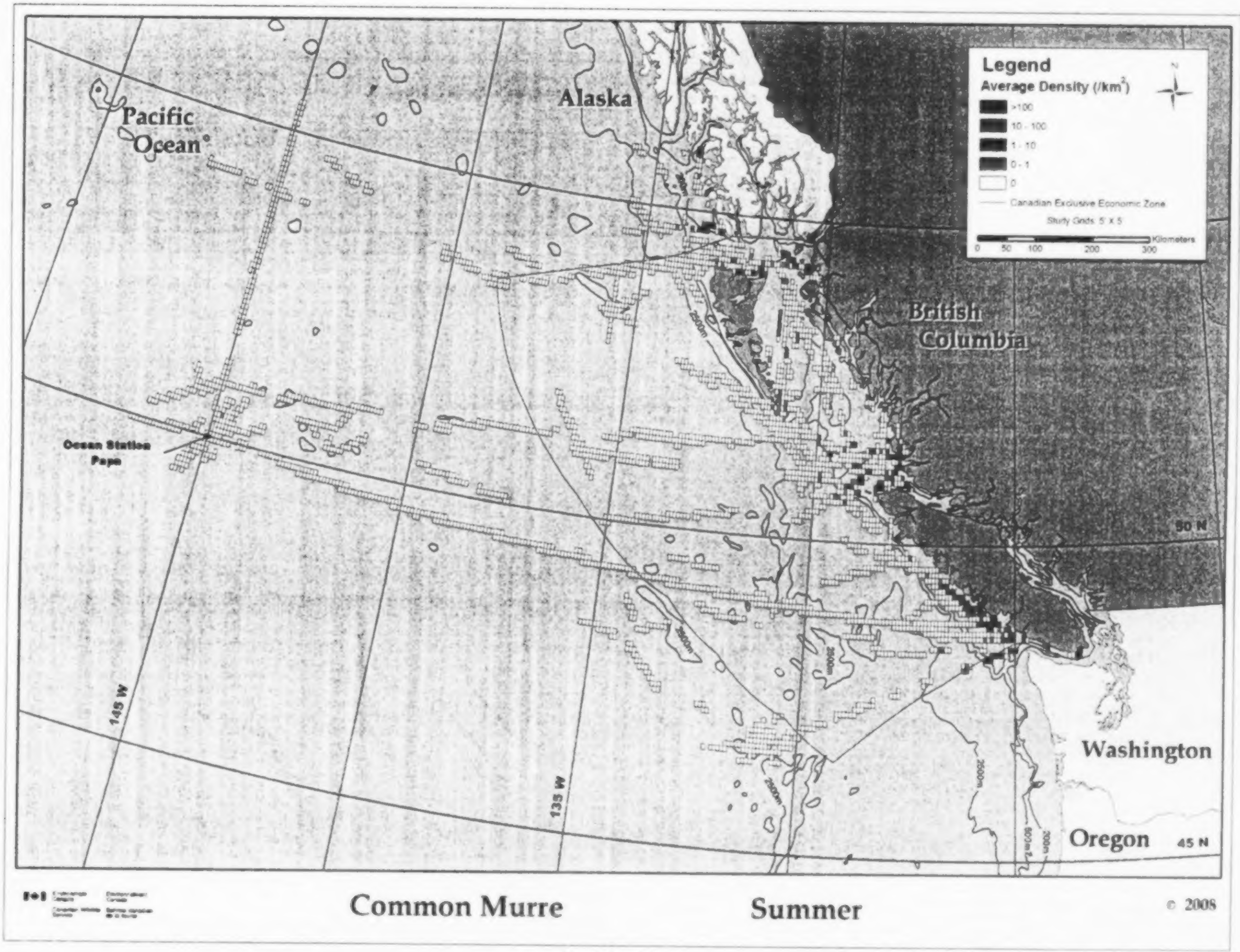

Figure 40B. Seasonal average grid cell densities of Common Murres.

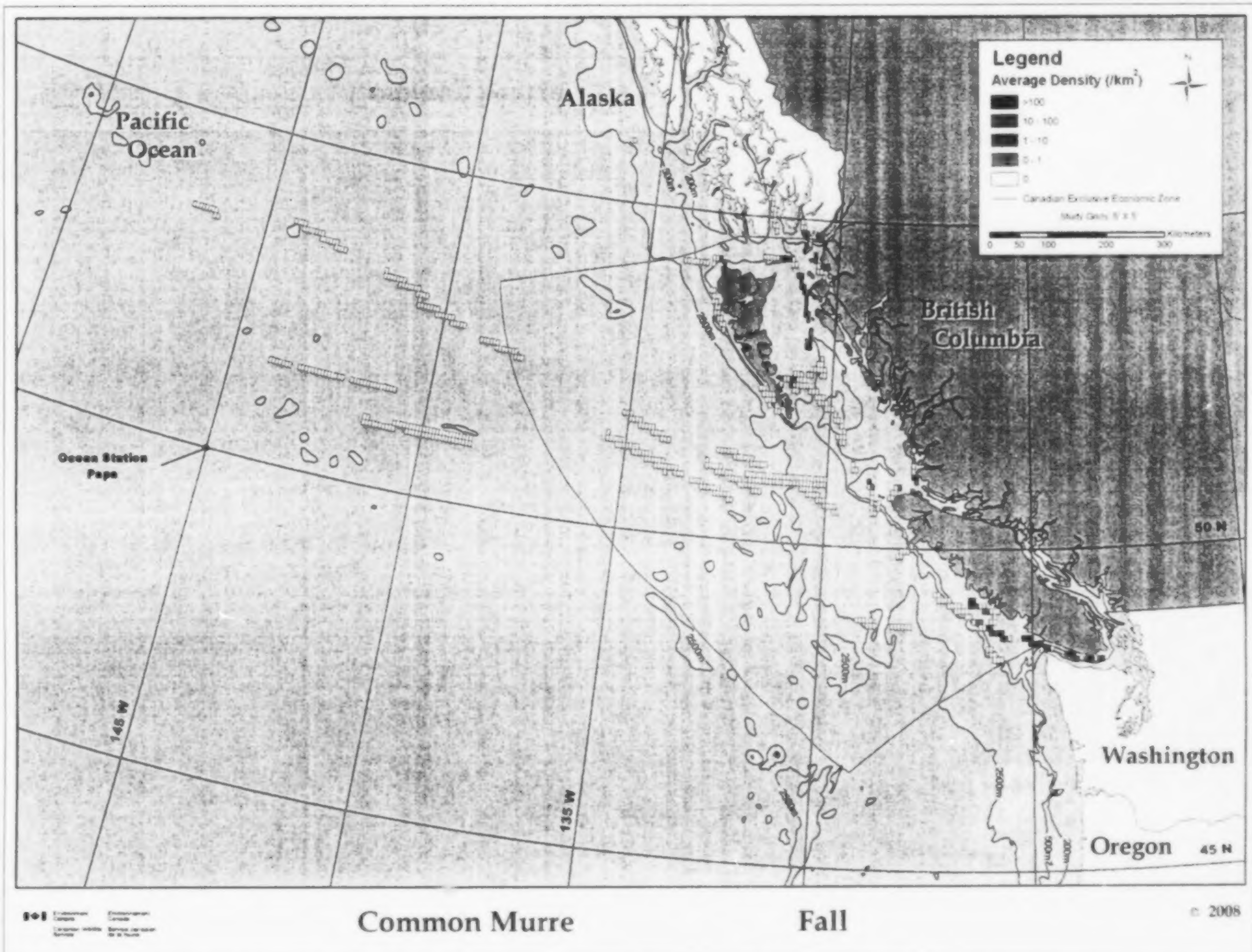

Figure 40C. Seasonal average grid cell densities of Common Murres.

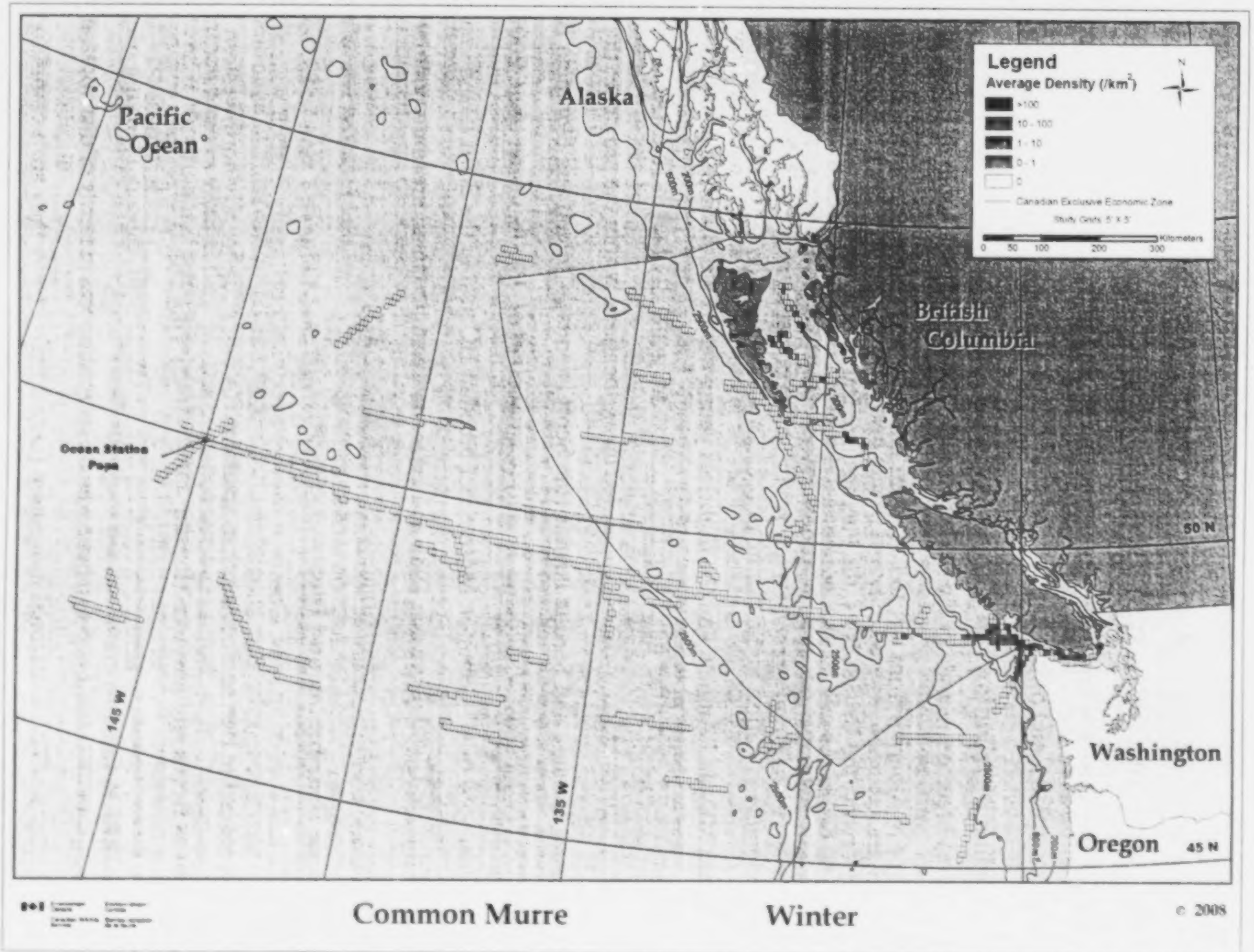

Figure 40D. Seasonal average grid cell densities of Common Murres.

3.1.9.1 Common Murre *Uria aalge*

3.1.9.1.1 Population and Conservation Status

With a global population of about 21 million individuals (Ainley *et al.* 2002), the Common Murre is listed by the IUCN as a species of *Least Concern* (BirdLife International 2008); and as a species of *Moderate* and *Low Conservation Concern* for N America and Canada, respectively (Kushlan *et al.* 2002, Milko *et al.* 2003). This species is on BC's *Red List* (BCCDC 2006) due to the relatively small, localized breeding populations in BC, and to the unknown level of impact of mortalities from bycatch and oiling.

3.1.9.1.2 Breeding Distribution and Chronology

Common Murres breed on islands in the Bering Sea, the Sea of Okhotsk south to Japan, along the west coast of N America from AK to CA, from Labrador and southeastern QC south to NS, Greenland to Norway, the British Isles, the Faeroes, the Baltic Sea, northwestern France and Portugal (Harrison 1983, Campbell *et al.* 1990b, Gaston and Jones 1998, Ainley *et al.* 2002). There is considerable variation in the timing of breeding depending on the colony location. Eggs are laid between May and August, and the flightless young depart the colony (accompanied by the male parent) 18-25 days after hatching. In BC, eggs are generally laid in June (Rodway 1990). Common Murres are known to have nested at six locations within the province: the Kerouard Islands, Triangle and Sartine Islands (the Scott Islands), Cleland and Florencia Islands and Starlight Reef (west coast Vancouver Island) (Campbell *et al.* 1990b, Carter *et al.* 2001, 2006). More than 95% of all Common Murres that breed in BC nest in the Scott Island group, primarily on Triangle Island. Between 1989 and 2003 the Triangle Island breeding population of Common Murres declined by approximately 27% (Hipfner 2005).

3.1.9.1.3 Oceanic Distribution and Diet

In the N Pacific and bordering seas, Common Murres overwinter primarily in shelf waters from the limit of sea ice in the Bering Sea, south to southern CA and occasionally northwestern MX; and as far south as Korea and northern Honshu, Japan (Harrison 1983, Ainley *et al.* 2002).
In the northern GOA, Common Murres were seen during all surveys, especially during Mar and April. Utilizing nearshore, shelf and offshore waters, their temporal patterns of distribution suggested an inshore-offshore seasonal movement (Day 2006). In WA they are a common to abundant resident along the outer coast, and a fairly common to common winter visitor. WA waters support an estimated 50,000 - 200,000 Common Murres in winter, representing as much

as 20 times the number of birds present during summer (Wahl *et al.* 2005). Off the west coast of Vancouver Island during October and November, Common Murres were significantly negatively associated with water depth, distance from land and sea-surface temperature (Vermeer *et al.* 1992).

Depending on the location, Common Murres are known to frequently forage up to 100 km from their breeding colonies, with a maximum recorded distance of 200 km (Briggs *et al.* 1987, Hatch *et al.* 2000, Gaston and Jones 1998). Fish dominate the diet of Common Murres during summer; small cephalopods and euphausiids are the main prey during winter and early spring. The main prey changes by latitude, but overall the fish most frequently reported taken by Common Murres are Arctic cod, capelin, eulachon, pollock, northern anchovy, Pacific herring, Pacific sandlance, rockfish species, saffron cod, sardine, and smelt. Invertebrate prey includes euphausiids (e.g., *Thysanoessa raschii, T. longipes, T. inermis*), amphipods (e.g., *Parathemisto libellula, Hyperia medusarum*), decapods, mysids and pandalid shrimp (DeGange and Sanger 1986, Vermeer *et al.* 1987c, Gaston and Jones 1998, Hunt *et al.* 2000, Ainley *et al.* 2002).

3.1.9.1.4 Spatial Distribution and *Average Grid Cell Density* in Study Area

Common Murres were observed year-round in the study area, commonly over the shelf and infrequently over waters deeper than 500 m (see also Hay 1992). This species is known to associate with steep temperature gradients in coastal regions (O'Hara *et al.* 2006).

In spring, Common Murres were most often observed over the shelf or slightly seaward of the shelfbreak, at low to moderate *average grid cell densities*. Occasionally, they were also encountered well offshore with the most distant being almost 825 km from land. The highest spring *average grid cell density* was 18.6 birds/km^2, when a group of 34 murres were encountered near Triangle Island (on 31 May 2001). During this season, most birds aggregated at the entrance of Juan de Fuca Strait, near the Scott Islands, and northern Hecate Strait.

Common Murres were at their peak abundance during summer, with the dominant *average grid cell densities* being 1.0-10.0 birds/km^2 and 10.0-100.0 birds/km^2. The highest summer *average grid cell density* (376.8 birds/km^2) resulted from the encounter of a raft of 145 birds seen near Calvert Island (on 31 August 2004). With one exception, all observations of Common Murres during summer occurred within approximately 100 km of land, usually much closer. The exception was the sighting of a Common Murre just north of OSP.

During fall, Common Murres were observed at lower densities (<10.00 birds/km^2), and only over the shelf and the shelfbreak. They were found off the southwest coast of Vancouver Island, in Hecate Strait and in the Strait of Juan de Fuca.

In winter, most Common Murres were observed over the shelf off the southwest coast of Vancouver Island and northern WA and in Juan de Fuca Strait. They were also encountered (but normally at lower densities) in Queen Charlotte Sound and Hecate Strait. The highest winter *average grid cell density* (15.5 birds/km^2) was located about 30 km west of the Olympic Peninsula. The farthest offshore record of a Common Murre during winter was roughly 125 km.

Common Murres are present in BC throughout the year; they are a very common to abundant spring migrant, very abundant in the vicinity of their colonies in summer, otherwise fairly common to very common on the outer coast, very abundant along the south coast during fall, and locally very common to very abundant in winter (Campbell *et al.* 1990b).

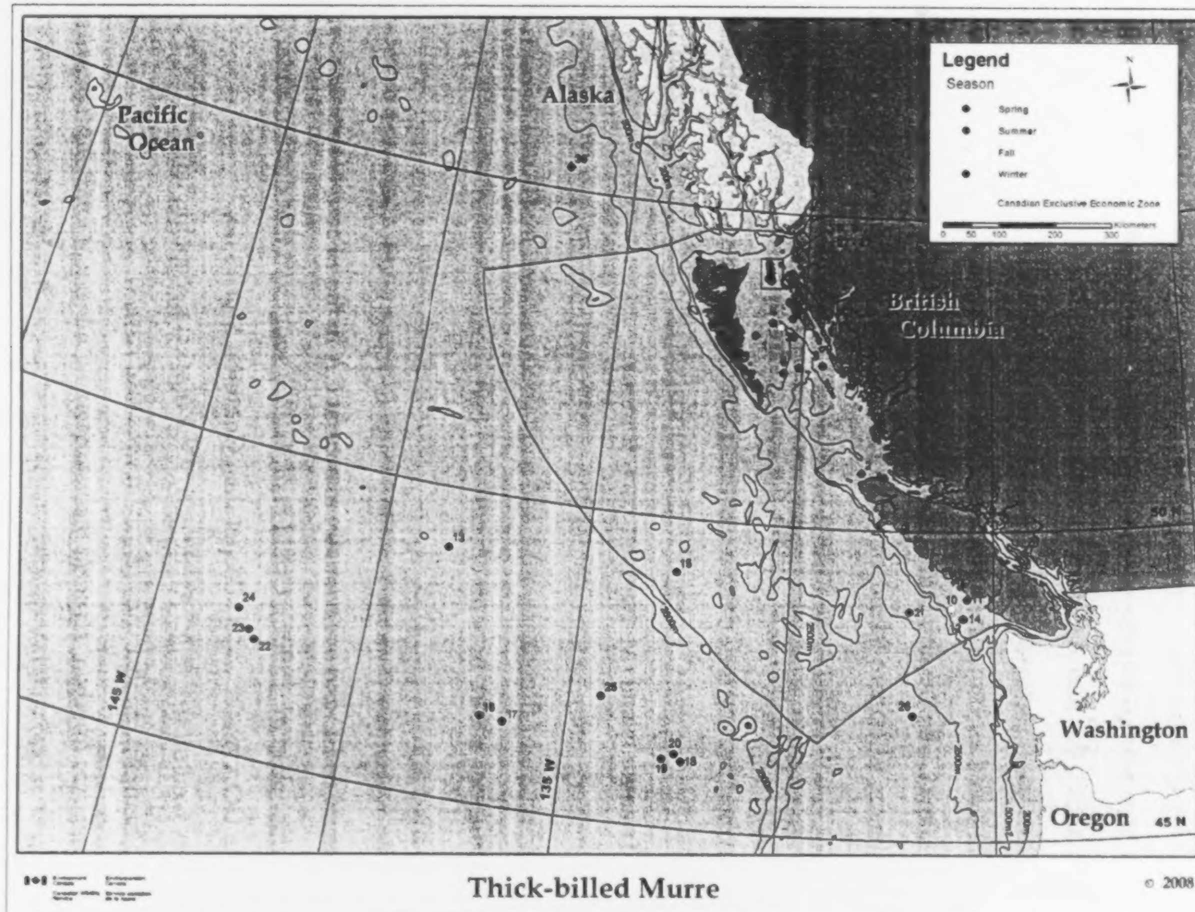

Figure 41. Locations where Thick-billed Murres have been observed.
See Appendix 1 for details.

3.1.9.2 Thick-billed Murre *Uria lomvia*

3.1.9.2.1 Population and Conservation Status

The worldwide population of Thick-billed Murres is estimated at 22 million birds; consequently they are considered to be a species of *Least Concern* by the IUCN (BirdLife International 2008). Kushlan *et al.* (2002) and Milko *et al.* (2003) rank the Thick-billed Murre as a species of *Moderate Conservation Concern* for N America and Canada, respectively. Due to a small nesting population in BC, this murre species is on the provincial *Red List* (BCCDC 2006).

3.1.9.2.2 Breeding Distribution and Chronology

Thick-billed Murres breed as far north in Siberia as Wrangel Island and along the coast of the Chukchi Sea from Cape Lisburn south throughout the Bering Sea, to the Aleutians, the GOA and the Commander Islands, Ellesmere Island, northern Hudson Bay, northern QC, NL, the St. Lawrence Gulf, Greenland, Iceland, Jan Mayen Land, Spitsbergen, Franz Josef Land and Norway (Harrison 1983, Campbell *et al.* 1990b, Gaston and Jones 1998). In 1981, Thick-billed Murres were discovered nesting on Triangle Island; at that time the breeding population was estimated at 19 pairs (Vallee and Cannings 1983, Campbell *et al.* 1990b). Currently, only about 10 pairs breed on Triangle Island (M. Hipfner, pers. comm.).

In the N Pacific, breeders return to the colonies during May or June, eggs are laid between June and August, and departure of flightless young and adults occurs about mid-August (Harrison 1983, Gaston and Hipfner 2000).

3.1.9.2.3 Oceanic Distribution and Diet

Thick-billed Murres overwinter from the ice-edge south to Japan in the western N Pacific, and to AK and less frequently to BC and occasionally to central CA in the eastern N Pacific (Harrison1983, Campbell *et al.* 1990b). Gould *et al.* (1982) suggested that during winter Thick-billed Murres in the GOA prefer waters deeper than Common Murres do.

Thick-billed Murres feed on fish (e.g., Arctic cod, Atka mackerel, capelin, lanternfish, Pacific sandlance, pollock, sculpin), euphausiids (e.g., *Thysanoessa raschii*, *T. inermis*, *T. longipes*), amphipods (*Parathemisto libellula, Hyperia medusarum*), squid (e.g., *Gonatopis borealis*, *Berryteuthis magister*, *B. anonychus*), mysids, decapods and polychaetes (Hunt *et al.* 1981, 2000, Ogi 1984, DeGange and Sanger 1986, Vermeer *et al.* 1987c, Gaston and Hipfner 2000). Thick-billed Murres will dive to depths >140 m in order to catch their prey (Elliott *et al.* 2007)

3.1.9.2.4 Distribution in Study Area

Thick-billed Murres were rarely reported in the study area; a total of 71 birds (39 encounters) were observed. Thick-billed Murres were seen most often during winter (approximately 54% of all observations), but >63% of the total number of birds were found during spring. During winter, Thick-billed Murres were seen most frequently offshore, although they were also observed nearshore, especially in Hecate Strait. During the rest of the year, they were most often found over the shelf.

In spring, Thick-billed Murres were found only in the northern sub-regions (Hecate Strait, Dixon Entrance, and the coast of southeast AK). Most of the spring observations occurred in early April. The largest group encountered was a raft of 12 murres seen in Dixon Entrance on 5 April 2004.

Very few Thick-billed Murres were seen during summer and fall (< 15% of the total observations); most were found over the shelf.

During winter, the majority of Thick-billed Murres were seen well offshore, mostly in the southern sub-regions. The most distant sighting was approximately 1,370 km west of the Olympic Peninsula.

According to Campbell *et al.* (1990b) Thick-billed Murres have been reported in BC from 8 May to 18 December. They considered it to be a very rare migrant and summer visitor (and local breeder) along the coast and accidental in winter. Wahl *et al.* (2005) consider the species to be a rare winter visitor. Our study suggests that Thick-billed Murres are present in low numbers throughout the year and are possibly more common than Campbell *et al.* (1990b) and Wahl *et al.* (2005) postulate.

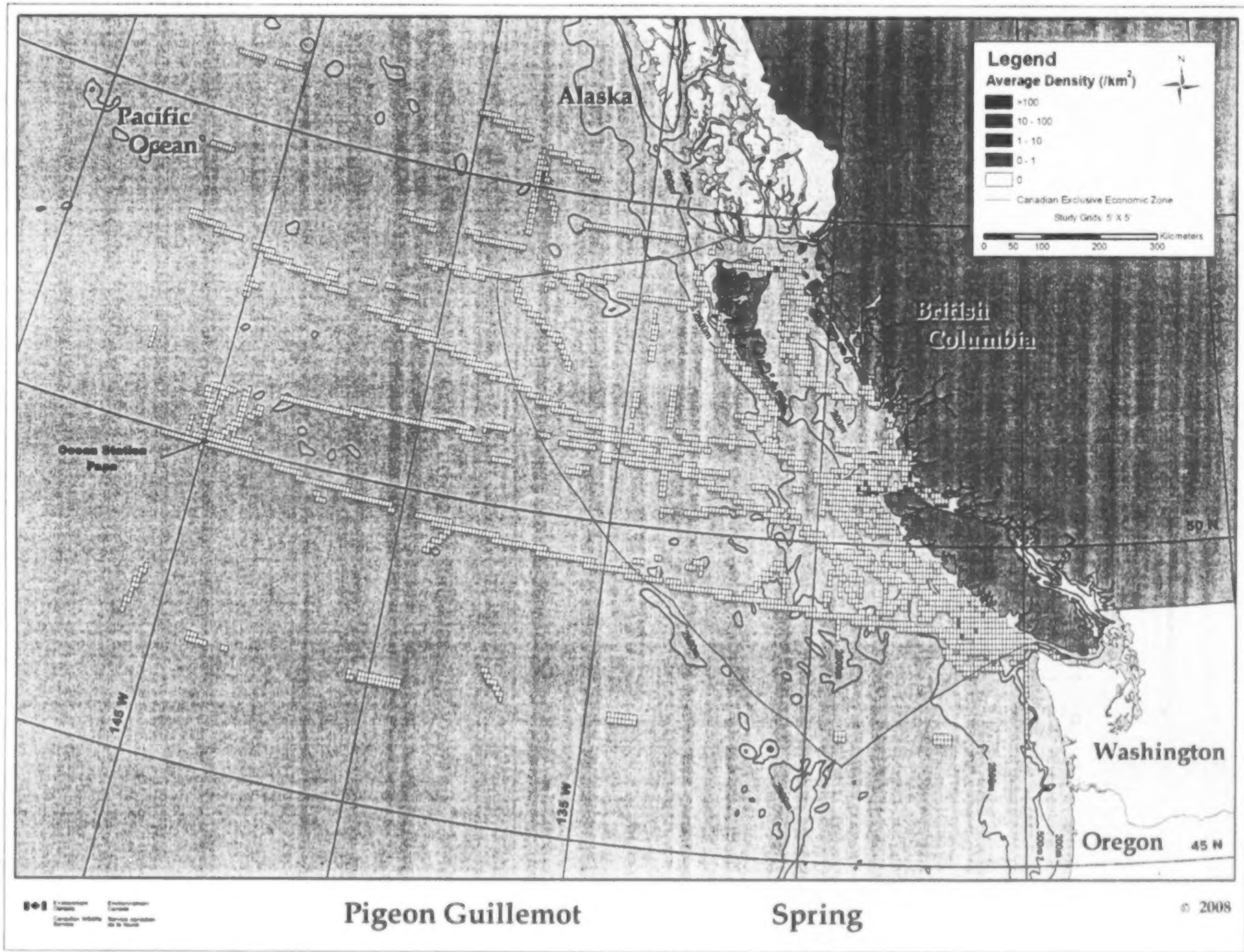

Figure 42A. Seasonal average grid cell densities of Pigeon Guillemots.

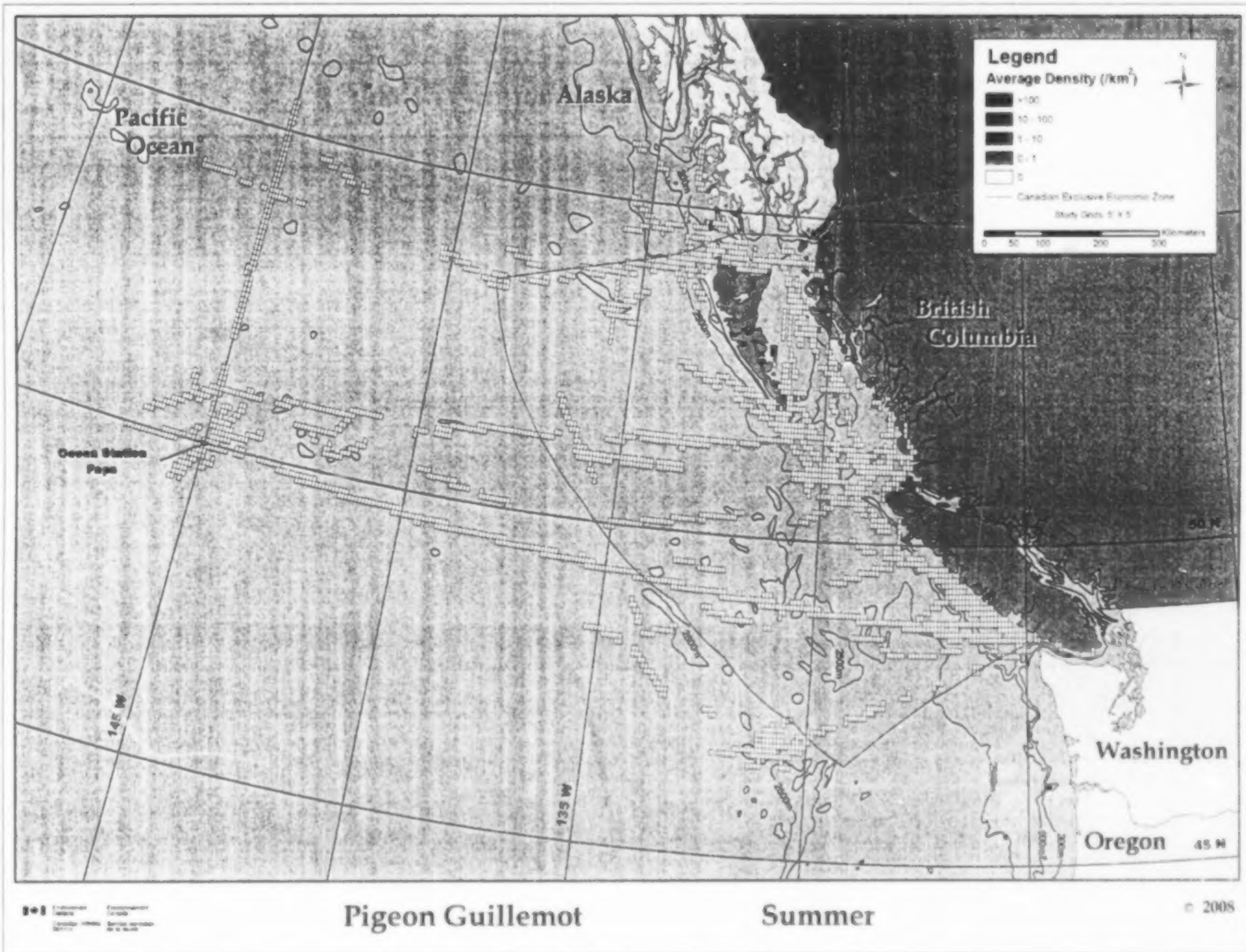

Figure 42B. Seasonal average grid cell densities of Pigeon Guillemots.

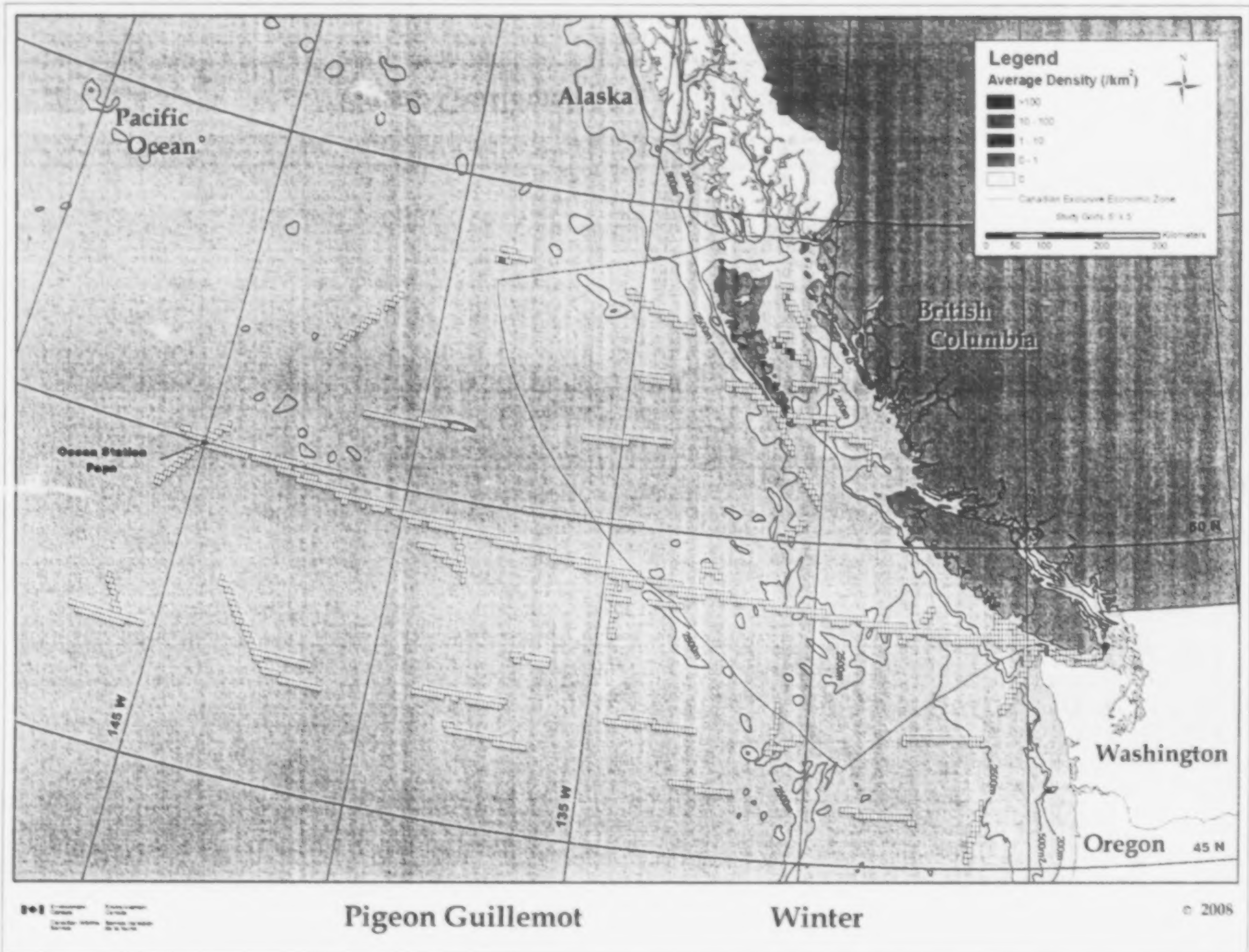

Figure 42C. Seasonal average grid cell densities of Pigeon Guillemots.

3.1.9.3 Pigeon Guillemot *Cepphus columba*

3.1.9.3.1 Population and Conservation Status

The Pigeon Guillemot has worldwide population of approximately 470,000 birds (Ewins 1993) and is globally ranked by the IUCN as a species of *Least Concern* (BirdLife International 2008). Kushlan *et al.* (2002) and Milko *et al.* (2003) list it as a species of *Moderate Conservation Concern* for N America and Canada, respectively. It is considered secure in BC (BCCDC 2006).

3.1.9.3.2 Breeding Distribution and Chronology

Pigeon Guillemots nest along rocky coastlines from northeast Siberia and the Chukchi Sea south through the Bering Sea, through Kamchatka and the Kuril Islands, the Aleutian Islands, the GOA to southern CA (Harrison 1983). This species is notoriously hard to survey, and although Gaston and Jones (1998) estimate that there are 10,200 Pigeon Guillemots in BC, the total number of birds present in the province may be considerably higher. To illustrate this, Rodway (1991) reported that there was approximately 740 individual Pigeon Guillemots nesting in Skidegate Inlet. In contrast, Vermeer *et al.* (1993b) found an estimated total of 2,747 birds in that same area. Accounting for the possibility of two-year-old non-breeders that were attending the colony, being included in the surveys, Vermeer *et al.* (1993b) speculated that there were 1,000 - 1,100 pairs of guillemots nesting in Skidegate Inlet in 1990. Assuming that surveys of other nesting sites have similarly underestimated the number of guillemots present, it is highly likely that the population is substantially larger than proposed by Gaston and Jones (1998).

Depending on the location, birds begin to assemble offshore of their breeding colonies in March to May, first eggs may appears as early as May, but most are laid between mid-May and July. Fledging and colony dispersal generally takes place in August and September (Harrison 1983, Ewins 1993).

3.1.9.3.3 Oceanic Distribution and Diet

The wintering areas of this species are largely unknown; they are mostly absent from many of their breeding areas during winter months. Wahl *et al.* (2005) noted that almost all outer WA coast Pigeon Guillemots move into protected waters during winter. Birds in breeding plumage (suspected to be migrants from OR and/or CA) were seen in WA waters in August and September flying north, >65 km from land. In support of this, Briggs *et al.* (1987) suggested that most nesting Pigeon Guillemots leave CA from August through February, and probably overwinter in nearshore waters in WA and BC.

During the breeding season, Pigeon Guillemots forage in shallow water generally within 7 km of their breeding colony; although, some birds (perhaps sub-adults and non-breeders) feed up to 15 km from land (Ewins 1993). Pigeon Guillemots are rarely recorded in BC's offshore waters (this study). Pigeon Guillemots occur throughout the year in WA; they are a locally common resident in inland waters, a locally common summer resident and rare in winter on the outer coast (Wahl *et al.* 2005).

Pigeon Guillemots eat a wide variety of prey, including many species of fish (e.g., black-bellied eelpout, capelin, cockscomb, crescent gunnel, decorated warbonnet, flatfish, gunnel, lamprey, lingcod, Pacific cod, Pacific herring, Pacific sandlance, rockfish species, juvenile salmon, scalyhead sculpin, shiner perch, smelt, snake prickleback, stickleback), as well as herring roe, shrimp (e.g., *Cragnon* and *Pandalus* spp.), crabs (e.g., *Cancer* and *Pagurus* spp.), and bivalves (e.g., *Mytilus spp.*) (DeGange and Sanger 1986, Vermeer *et al.* 1987c, Ewins 1993, Vermeer *et al.* 1993b).

3.1.9.3.4 Spatial Distribution and *Average Grid Cell Density* in Study Area

In spring, Pigeon Guillemots were observed in small groups near the Scott Islands, Cook Bank, and a few off the northeast tip of Graham Island. The highest *average grid cell density* (47.6 birds/km^2) occurred in Haro Strait. With the exception of one sighting, all Pigeon Guillemots were found within approximately 10 km of shore. The exception was of a bird seen approximately 70 km west of Barkley Sound.

The highest summer *average grid cell density* of Pigeon Guillemots (6.3 birds/km^2) occurred east of Louise Island. Guillemots were also observed in the mouth of Queen Charlotte Strait, near Pine Island, and Storm and Tree Islets; at the southern tip of Moresby Island, east and west of Cape St. James; at very low densities in Queen Charlotte Sound (east to Caamano Sound) and Dixon Entrance; and near Forrester Island (AK). All birds were encountered over the shelf.

Pigeon Guillemots were not observed within the study area during fall surveys. In winter they were encountered in central Hecate Strait (*average grid cell densities* <0.7 bird/km^2) and in Juan de Fuca Strait (1.5-2.1 birds/km^2). The most offshore observation of Pigeon Guillemots took place during winter when two birds were encountered almost 375 km west of Graham Island.

According to Campbell *et al.* (1990b) Pigeon Guillemots occur within BC waters throughout the year; they are a common to abundant spring migrant, a locally very common to abundant

summer visitor, fairly common to very common coastally during fall, and locally common to abundant in winter on the inner south coast.

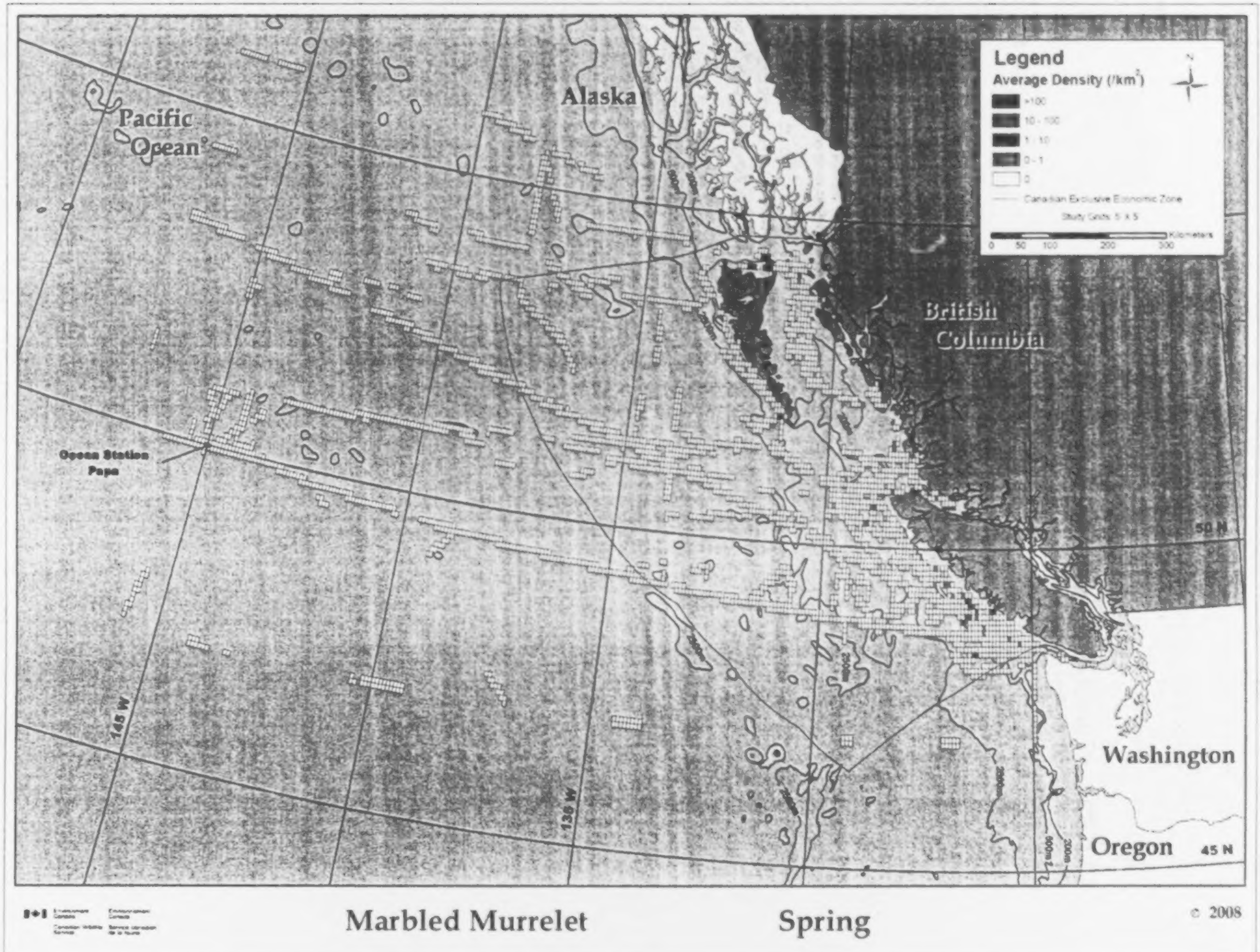

Figure 43A. Seasonal average grid cell densities of Marbled Murrelets.

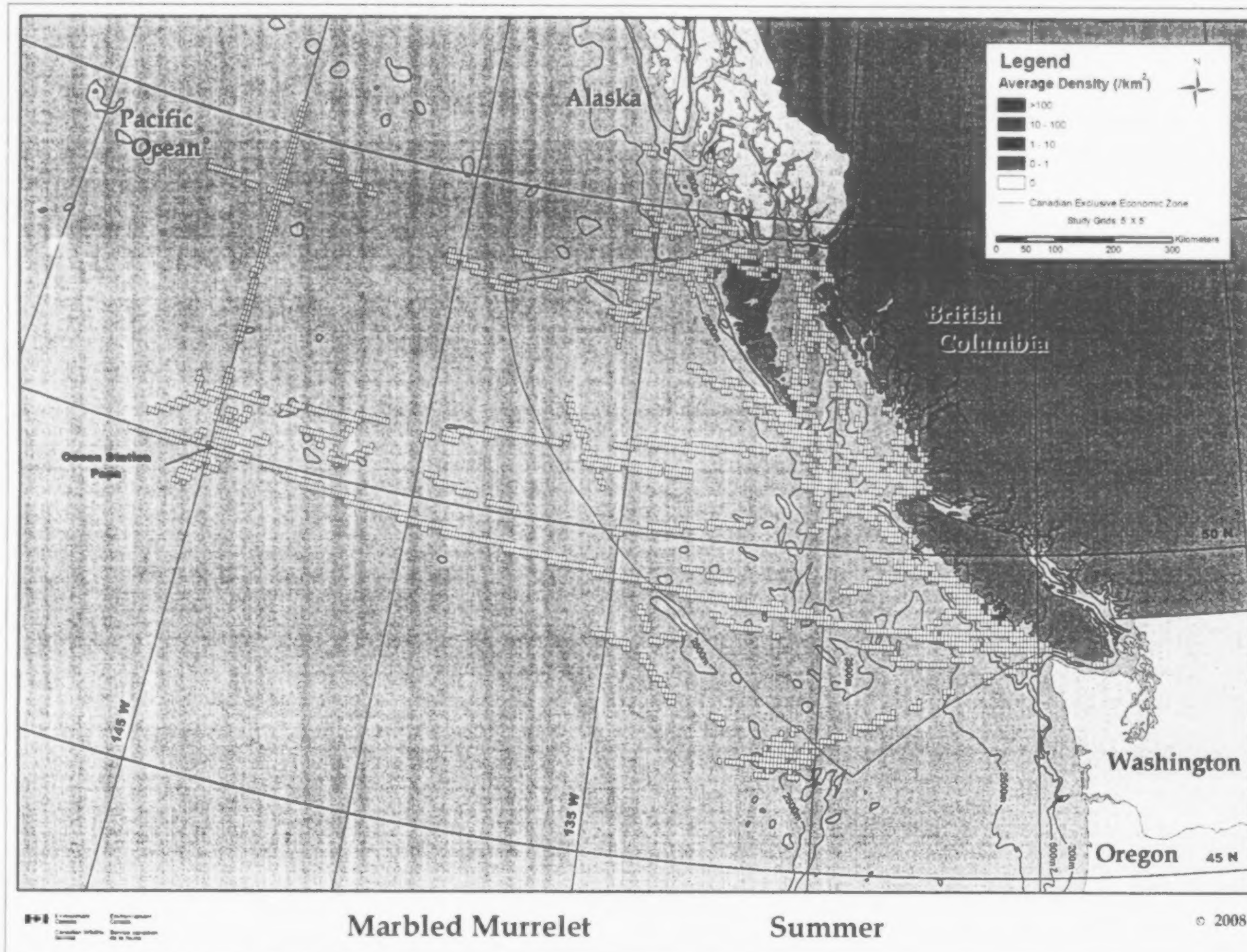

Figure 43B. Seasonal average grid cell densities of Marbled Murrelets.

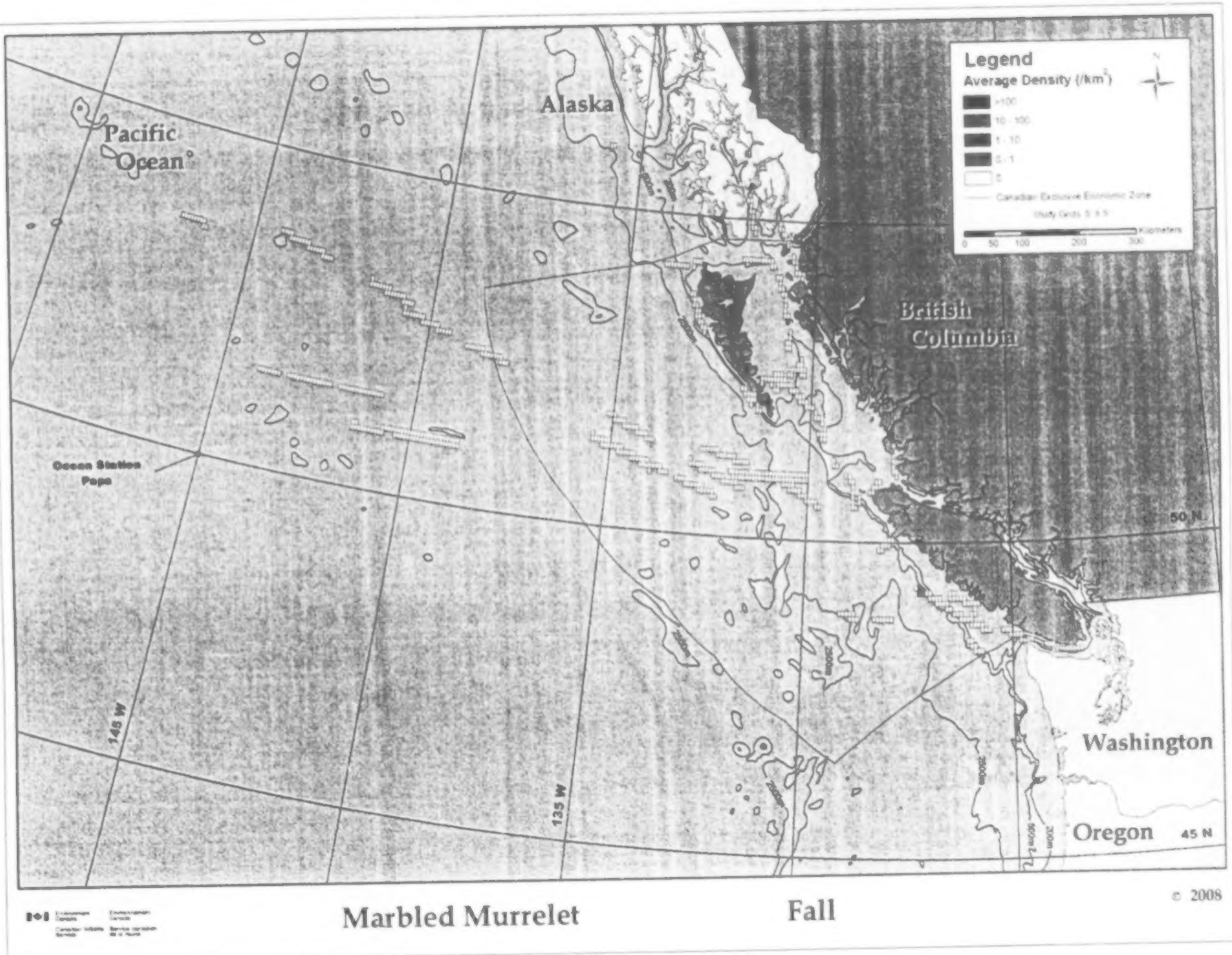

Figure 43C. Seasonal average grid cell densities of Marbled Murrelets.

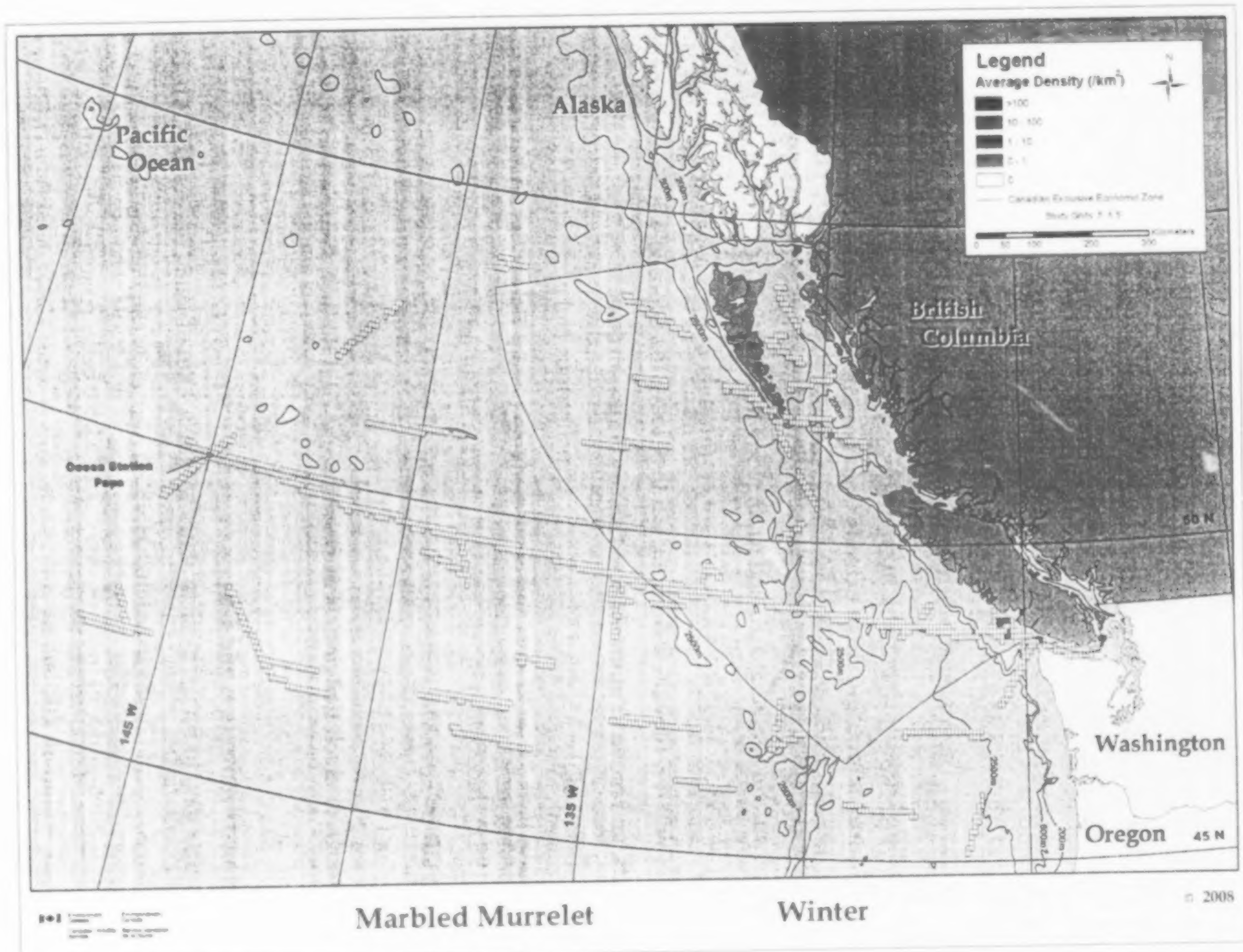

Figure 43D. Seasonal average grid cell densities of Marbled Murrelets.

3.1.9.4 Marbled Murrelet *Brachyramphus marmoratus*

3.1.9.4.1 Population and Conservation Status

The total population of Marbled Murrelets in BC is thought to be between 54,300 and 92,600 birds (median 73,000 rounded) (Piatt *et al.* 2007); and the global population is estimated to be somewhere between 475,000 and 760,000 birds (BirdLife International 2008). The species is listed globally by the IUCN as *Endangered* (BirdLife International 2008), and was designated as *Threatened* in Canada in 1990 (COSEWIC 2008). The species is listed as *Vulnerable* to *Apparently Secure* by NatureServe (2008), and Kushlan *et al.* (2002) and Milko *et al.* (2003) rank the Marbled Murrelet as a species of *High Conservation Concern* for N America and Canada, respectively. The Marbled Murrelet is on the BC Red-list (BCCDC 2006).

3.1.9.4.2 Breeding Distribution and Chronology

The Marbled Murrelet breeding range extends from the western Aleutian Islands, northeast to Cook Inlet, Kodiak Island, Kenai Peninsula, and Prince William Sound, and south through the Alexander Peninsula in southeast AK, and south along the coasts of BC to central CA (Nelson 1997, Ralph *et al.* 1995). Marbled Murrelets winter throughout their breeding range (Campbell *et al.* 1990b), although it is thought that during fall they leave the exposed waters of the outer coast and large straits, and move to more sheltered waters (Burger 1995).

The breeding season of the Marbled Murrelet is asynchronous and protracted (Lougheed *et al.* 2002). Incubation lasts 28 to 30 days and chick fledging occurs from 27 to 40 days post hatching (Hirsch *et al.* 1981). Incubation in AK generally begins about mid-May; egg-laying commences in BC through OR in early May, and eggs may be found in CA as early as the third week of March (Hamer and Nelson 1995). In southern BC, the entire breeding season (from egg-production through to chick fledging) lasts from March/April through September (McFarlane Tranquilla *et al.* 2003, 2005b).

3.1.9.4.3 Oceanic Distribution and Diet

Marbled Murrelets tend to forage close to shore within 3.0 km of land (Burger 2002) in coastal inlets and fjords. Ronconi (2008) found that Marbled Murrelets showed preferences for shallow, nearshore waters, often closer to beaches, and close to kelp beds. Associations with substrate have been mixed, including affiliations with glacial sills (Carter 1984), tidal flats (Miller *et al.* 2002), and sandy shorelines in British Columbia (Yen *et al.* 2004). Their foraging locations may be 100 km or more from their inland nest sites (Nelson 1997, Hull *et al.* 2001). In WA, Marbled

Murrelets are most numerous year-round in inland waters, and on the outer coast, they are most abundant from approximately mid-February through mid-October (Wahl *et al.* 2005).

There is considerable geographic and temporal variation in the diet of Marbled Murrelets. Fish (e.g., capelin, eulachon, northern anchovy, Pacific herring, Pacific sandfish, Pacific sandlance, pollock, rockfish species, sardine, shiner perch, smelt) and euphausiids (e.g., *Thysanoessa inermis*, *T. raschii*, *T. spinifera*, *Euphausia pacifica*) are the dominant prey. Marbled Murrelets also feed upon herring roe, polychaetes, gastropods, bivalves, mysids, gammarid amphipods, squid (e.g., *Loligo* spp.), decapods and shrimp (DeGange and Sanger 1986, Burkett 1995, Gillespie and Westrheim 1997, Burger 2002). Fish make up the largest part of their diet during summer (i.e., during the nestling and fledgling periods); whereas, euphausiids and other invertebrates are far more important during the non-breeding season (Burkett 1995).

3.1.9.4.4 Spatial Distribution and *Average Grid Cell Density* in Study Area

Throughout all seasons, *average grid cell densities* for Marbled Murrelets did not exceed 10.0 birds/km^2. Similar to that presented by Morgan *et al.* (1991), the majority of Marbled Murrelets were found inshore of the 200 m isobath, and generally within 50 km of shore. The highest *average grid cell densities* were in spring and summer.

In spring, Marbled Murrelets were most frequently recorded off the north coast of Graham Island, but were also relatively common west of Quatsino and Clayoquot Sounds. They were also recorded west of Cape St. James, in Queen Charlotte Sound, Hecate Strait, and scattered along the west coast of Vancouver Island. The farthest offshore a Marbled Murrelet was seen during spring was about 85 km southwest of Amphitrite Point.

Marbled Murrelets were abundant during summer in Dixon Entrance, off the northwest coast of Graham Island (maximum *average grid cell density* 7.3 birds/km^2) and near Clayoquot Sound (2.0-5.0 birds/km^2). The largest group observed (during any season) was a raft of 20 birds seen approximately 30 km north of Graham Island on 29 June 1994. Lower *average grid cell densities* (> 1.0 bird/km^2) were located near Calvert Island; between Goose and Hunter Islands (Queen Charlotte Sound); and near Hope and Nigei Islands (Queen Charlotte Strait). The farthest offshore sighting was of an individual bird found about 90 km west of Clayoquot Sound, seen on 1 September 2001.

Very few Marbled Murrelets were seen during fall; only six birds were observed and consequently AGCDS were low (0.2-0.6 bird/km^2). Birds were only encountered about 20 km west of Banks Island, and approximately 45 km west of Estevan Point.

Marbled Murrelets were observed at low *average grid cell densities* during winter (mostly <1.0 bird/km^2); primarily west and southwest of Barkley Sound, although birds were also found off the southern tip of Moresby Island and at the edge of the shelf in Queen Charlotte Sound. The highest density of Marbled Murrelets occurred in Haro Strait. The farthest offshore this species was seen during winter was about 95 km east southeast of Cape St. James.

According to Campbell *et al.* (1990b) the Marbled Murrelet is the most widely distributed alcid in BC; they have been observed in every month, with approximately 65% of sightings occurring between the beginning of May and the end of August.

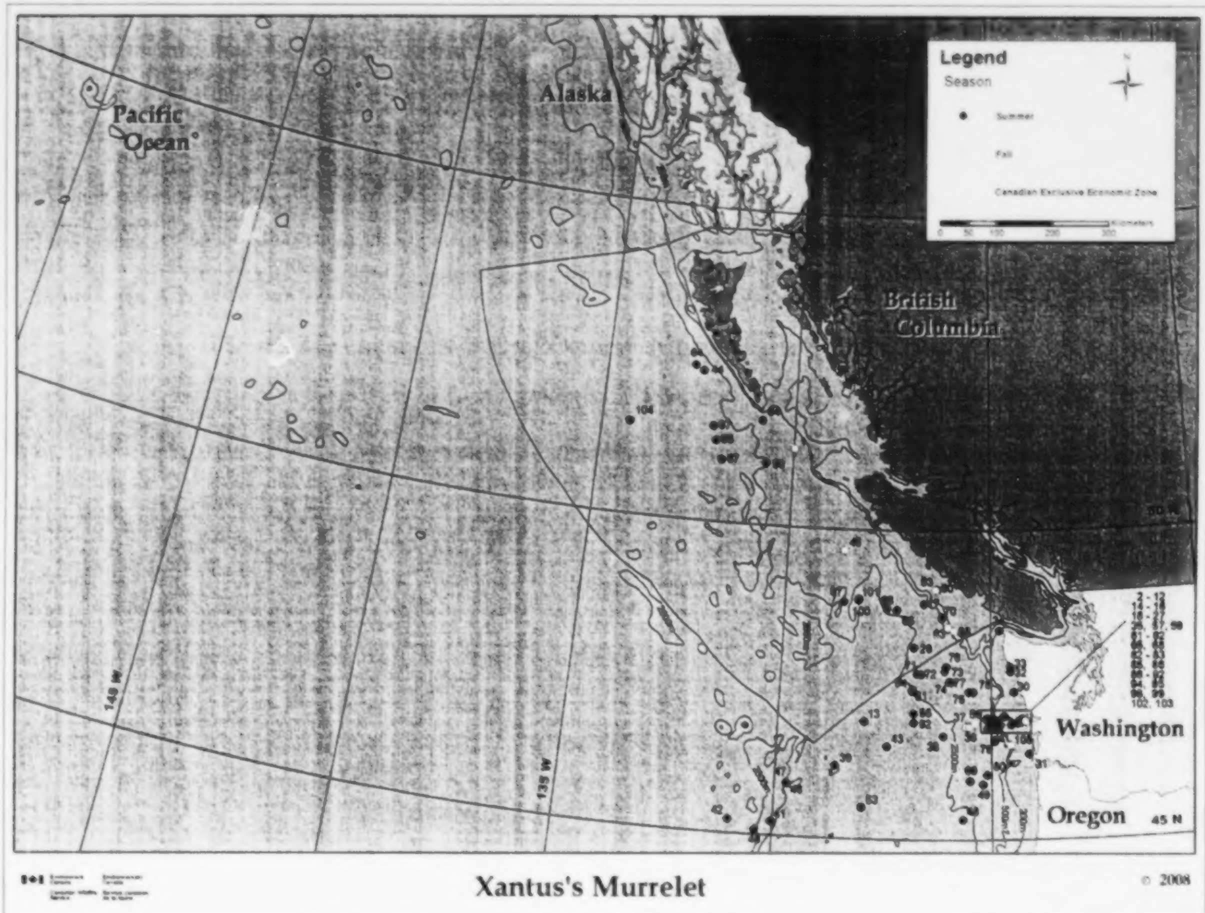

Figure 44. Locations where Xantus's Murrelets have been observed.

See Appendix 1 for details.

3.1.9.5 Xantus's Murrelet *Synthliboramphus hypoleucus*

3.1.9.5.1 Population and Conservation Status

The IUCN lists the Xantus's Murrelet as globally *Vulnerable* due to a small breeding population (estimated to be between 2,070 and 5,650 pairs) that nests primarily on four islands offshore of southern CA and the Baja Peninsula, MX (BirdLife International 2008). However, using at-sea and aerial survey data, Karnovsky *et al.* (2005) calculated that the total global population of Xantus's Murrelet was considerably larger than believed. They estimated the total population to be approximately 39,700 birds, and that the global breeding population was around 17,900 birds. The Xantus's Murrelet is listed as a species of *High Conservation Concern* for N America and Canada (Kushlan *et al.* 2002, Milko *et al.* 2003), respectively.

3.1.9.5.2 Breeding Distribution and Chronology

Xantus's Murrelets are endemic to the Pacific Coast of N America, breeding on up to 12 islands off the coast of southern CA and northwestern Baja California. Two subspecies are recognized: *S. h. hypoleucus* breeds almost entirely off the central, west coast of Baja California, and *S. h. scrippsi* nests primarily on the Channel Islands and Islas Coronados (Jehl and Bond 1975, Drost and Lewis 1995). Approximately 80% of the world population breeds on Santa Barbara Island (Channel Islands) and on MX's Los Coronados, San Benito and Guadalupe Islands (Drost and Lewis 1995). Breeding mainly takes place between mid-February and June (Murray *et al.* 1983, Drost and Lewis 1995).

3.1.9.5.3 Oceanic Distribution and Diet

Coming ashore for only a few months to breed, mainly between mid-February and June, Xantus's Murrelets spends most of their lives at sea. They range along the west coast of N America from off Baja California (roughly 23° N) to approximately 52.5° N (Drost and Lewis 1995, Karnovsky *et al.* 2005). Post-breeding, the species disperses generally northward and offshore, from central CA to central BC (Roberson 1980, Whitworth *et al.* 2000). Until recently, the northern at-sea limit of this species was thought to be somewhere between Vancouver Island and the Queen Charlotte Islands (Sanger 1973). However, they range farther north (to approximately 52.5° N) during late summer (Karnovsky *et al.* 2005). Although many of the sightings of Xantus's Murrelets occurred within 200 km of shore, birds were encountered up to approximately 550 km offshore of the OR coast (L. Ballance, unpubl. data 2007).

There is little information about the diet of Xantus's Murrelets; however, it appears that they feed predominantly on forage fish (e.g., northern anchovies, rockfish species, Pacific saury, Springer *et al.* 1993, Drost and Lewis 1995).

3.1.9.5.4 Distribution in Study Area

Although specimens of Xantus's Murrelets had been obtained from WA and BC several decades earlier, this species was virtually unknown in both locales until systematic pelagic trips began in the 1970's and 1980's (Carter *et al.* 2005, Wahl *et al* 2005). The first specimen record of Xantus's Murrelet in BC was that of an adult female that collided with a vessel in southern Hecate Strait on 25 October 1971 (Sanger 1973).

Xantus's Murrelets were observed in the study area from 20 June through 31 October; however they were most common between mid-July and late September/early October. Roughly 50% of all of the Xantus's Murrelet sightings occurred west of Grays Harbor; that is due to the large number of surveys that have been conducted there since 1971 by *Westport Seabirds* (T. Wahl, pers. comm.).

Of the 105 Xantus's Murrelet sightings (comprising 228 birds) presented here, 55 birds were identified to subspecies (34 *S. h. scrippsi*, 21 *S. h. hypoleucus*). Of those, *scrippsi* were found over shallower waters (average water depth 946 m, SE = 286.1, n = 12) and closer to shore (average distance 56 km [SE = 7.9, n = 12]) than *hypoleucus* (average water depth 2,150 m [SE = 336.2, n = 10], average distance to shore 170 km [SE = 50.1, n = 10]). Both the depths and the distance of the sighting locations to shore, differed significantly between subspecies (depth: $p = 0.009$, $F = 8.39$ [1, 19]; distance: $p = 0.018$, $F = 6.77$ [1, 19]) (K. Morgan, unpubl. data 2007). These results in part support the speculation by Carter *et al.* (2005) and Wahl *et al.* (2005) that following breeding, *hypoleucus* "leapfrog" over *scrippsi* and occur farther north, as well as farther offshore.

Xantus's Murrelet is considered accidental in BC (Campbell *et al.* 1990b); whereas, in WA it is classified as a very rare to rare visitor to the outer shelf.

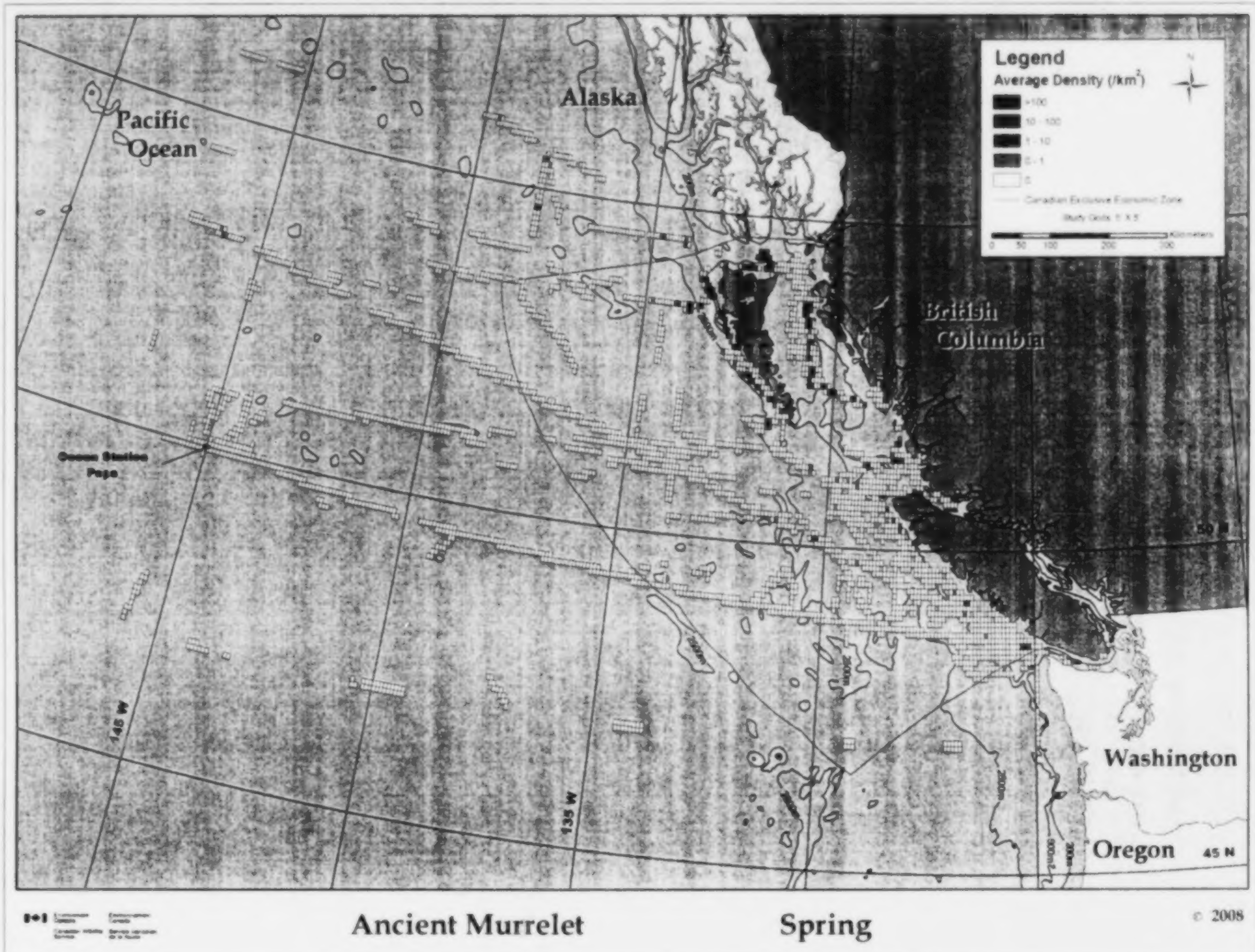

Figure 45A. Seasonal average grid cell densities of Ancient Murrelets.

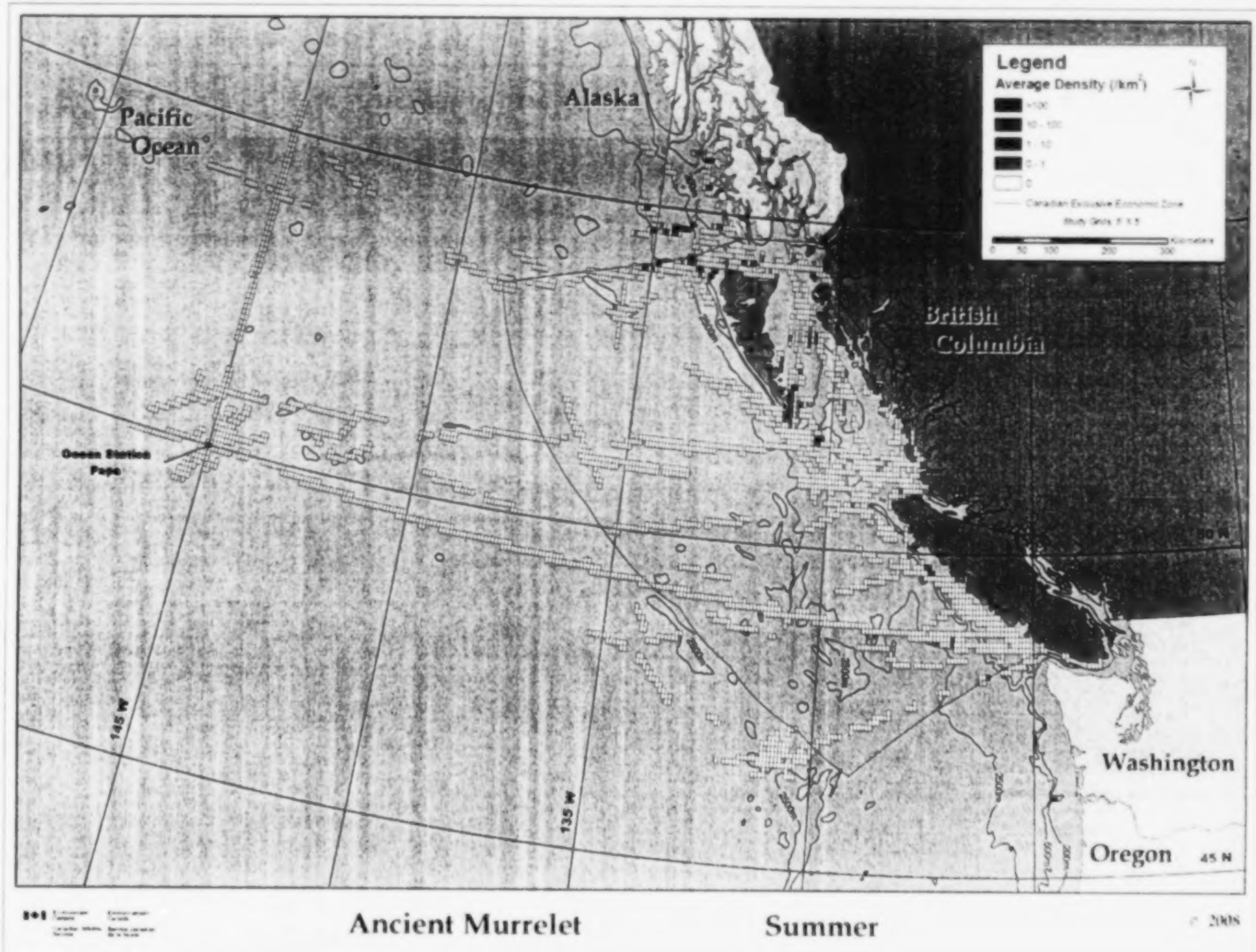

Figure 45B. Seasonal average grid cell densities of Ancient Murrelets.

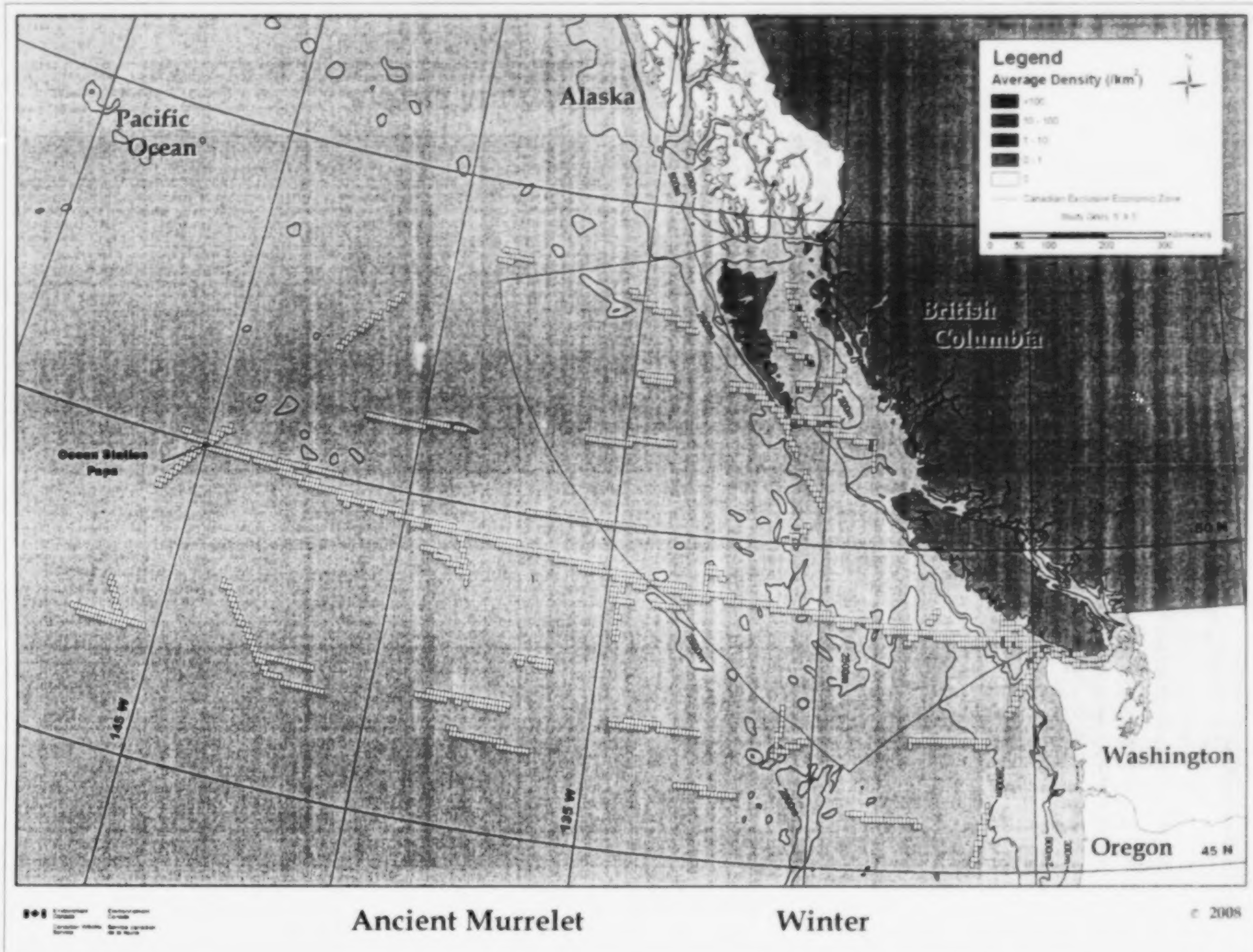

Figure 45C. Seasonal average grid cell densities of Ancient Murrelets.

3.1.9.6 Ancient Murrelet *Synthliboramphus antiquus*

3.1.9.6.1 Population and Conservation Status

The Ancient Murrelet has a worldwide population estimated at about one million birds and it is globally ranked by the IUCN as a species of *Least Concern* (BirdLife International 2008). Kushlan *et al*. (2002) and Milko *et al.* (2003) list the Ancient Murrelet as a species of *High Conservation Concern* for N America and Canada, respectively. It is listed as a species of *Special Concern* in Canada (COSEWIC 2004b) and is on BC's *Blue List* (BCCDC 2006).

3.1.9.6.2 Breeding Distribution and Chronology

This species breeds from the Commander Islands and Kamchatka Peninsula south through the Kuril Islands to Korea; and from the Aleutian Islands east to the Alaskan Peninsula and the QCI (Harrison 1983, Gaston and Jones 1998). Approximately 500,000 Ancient Murrelets breed in BC, at >30 sites on the QCI (Gaston and Jones 1998); the largest colonies are on Frederick, Hippa, and Rankine Islands (Rodway 1991, Gaston 1994).

In BC, mean clutch completion occurs between 17 April and 9 May, but egg-laying is spread over about 45 days (Gaston 1994). Incubation lasts 29 to 31 days; after two to three days, the precocial chicks join the adults at sea where they continue to develop (Harrison 1983, Gaston 1994).

3.1.9.6.3 Oceanic Distribution and Diet

In the northern GOA, Ancient Murrelets are rare to uncommon during spring and rare in fall, primarily seen mid-shelf (Day 2006). They have been observed in WA throughout the year; they are locally fairly common to abundant migrants and winter visitors offshore and in inland marine waters (Wahl *et al*. 2005). Off central and southern CA, these murrelets are found in low numbers during winter (January through April), mostly seaward of the shelfbreak (Briggs *et al.* 1987). Ancient Murrelets forage primarily over the shelfbreak, but occasionally over the shelf as well (Vermeer *et al.* 1984).

The summer diet of Ancient Murrelets has been well described for BC; the birds feed on roughly equal proportions of fish (e.g., Pacific sandlance, rockfish species, shiner perch) and euphausiids (e.g., *Thysanoessa spinifera*, lesser amounts of *T. pacifica*) (Sealy 1975, Vermeer *et al.* 1985). Elsewhere they forage on other fish (e.g., Pacific herring, Pacific saury, rainbow smelt, sculpin), and other invertebrates (e.g., *T. inermis*, crangonid shrimp, small squid) (DeGange and Sanger 1986, Springer *et al.* 1993).

3.1.9.6.4 Spatial Distribution and *Average Grid Cell Density* in Study Area

Ancient Murrelets were seen in the study area in spring, summer, and winter, but not fall. During spring, they were most abundant along the edge of the shelfbreak/slope region, but were also well offshore (as far as approximately 845 km west of Graham Island). They were most common along the west and north coasts of the QCI, in Hecate Strait, and to a lesser extent, in Queen Charlotte Sour l. They were also found at low densities west of Vancouver Island. The largest assemblage of Ancient Murrelets that we observed was in late spring; on 6 June 1995 a raft of 236 Ancient Murrelets was seen about 30 km north of Graham Island.

Highest *average grid cell densities* during summer were near Langara Island (10.0-13.1 birds/km^2), as well as in US waters to the northwest of Langara Island. Ancient Murrelets were observed at lower densities west of Graham Island (from 115-170 km offshore), off the southern end of Moresby Island, and in Hecate Strait and Queen Charlotte Sound. Few Ancient Murrelets were seen near Vancouver Island in the summer.

Very few Ancient Murrelets were observed during winter. The largest group of birds (26) was seen on 8 February 2000 in central Hecate Strait, producing an *average grid cell density* of 24.3 birds/km^2. They were also found at lower densities (0.2-7.1 birds/km^2) elsewhere in Hecate Strait, Queen Charlotte Sound, southwest of Barkley Sound, west of the Olympic Peninsula, and in Juan de Fuca Strait.

Ancient Murrelets are present year-round in BC waters; they are a common to abundant spring and fall migrant, rare to uncommon on the south coast during summer, fairly common to common along the northern mainland coast in summer, locally very abundant in late spring and early summer in the QCI, an abundant to very abundant winter visitor off the south coast of Vancouver Island and rare elsewhere in winter (Campbell *et al.* 1990b).

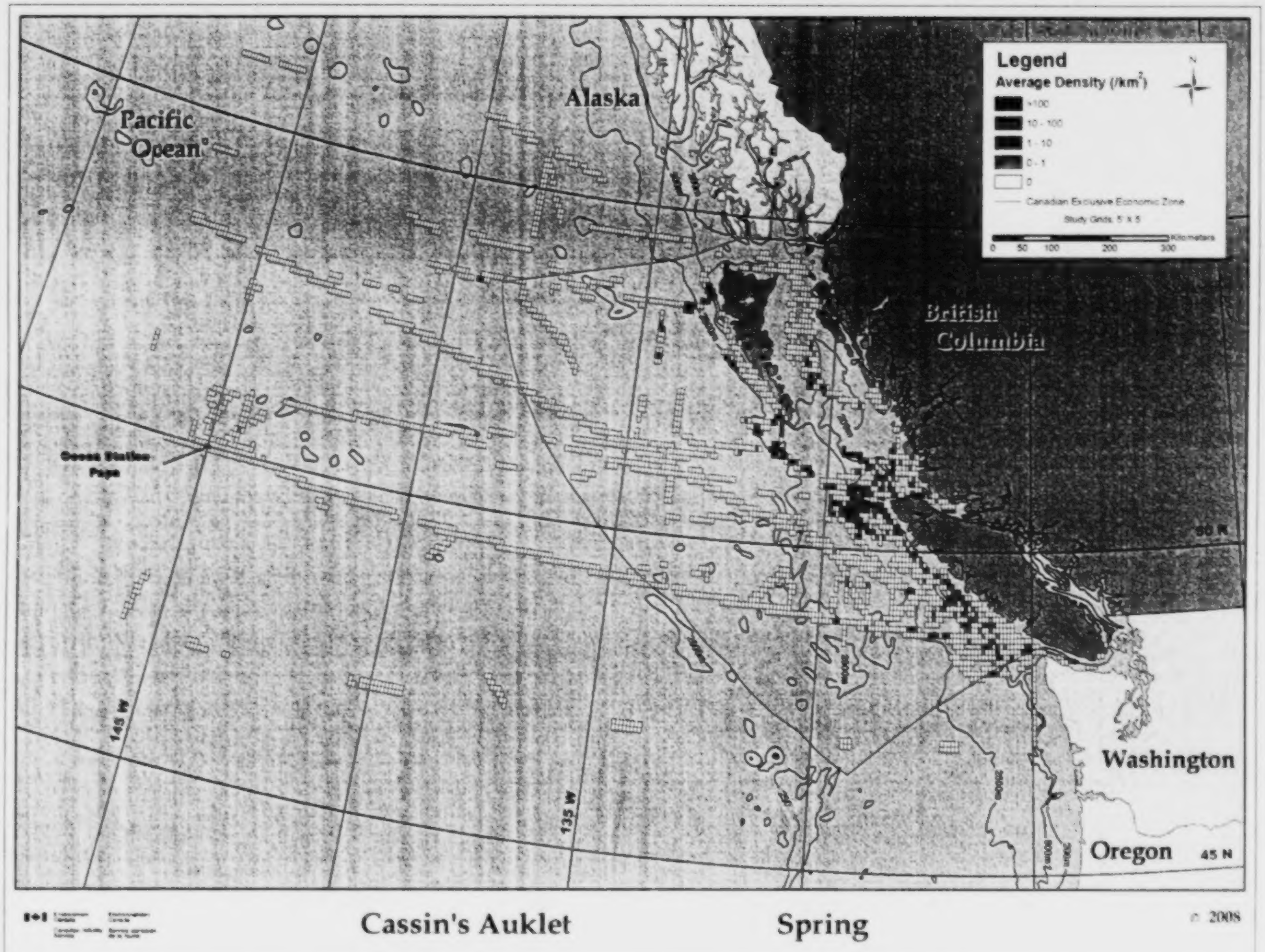

Figure 46A. Seasonal average grid cell densities of Cassin's Auklets.

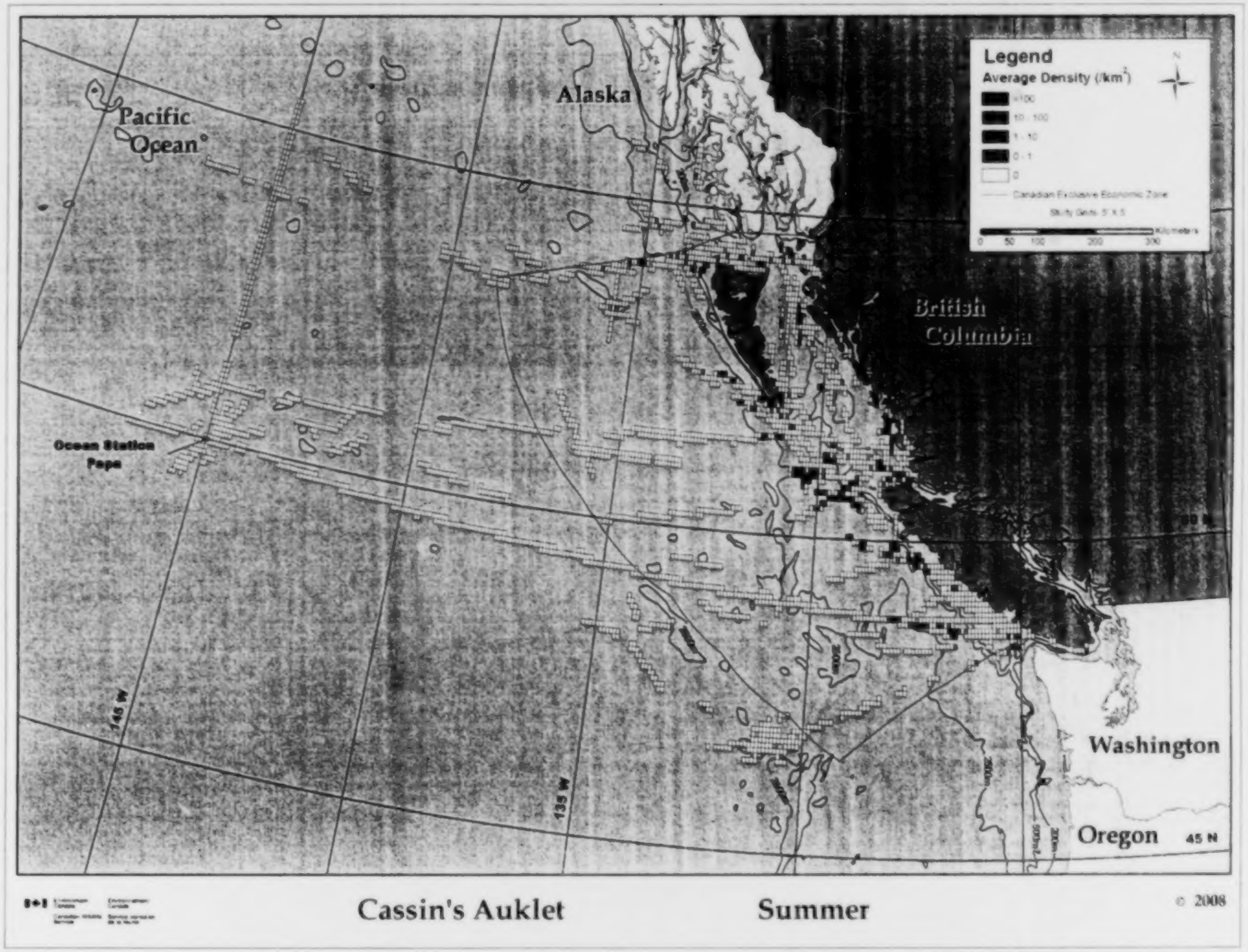

Figure 46B. Seasonal average grid cell densities of Cassin's Auklets.

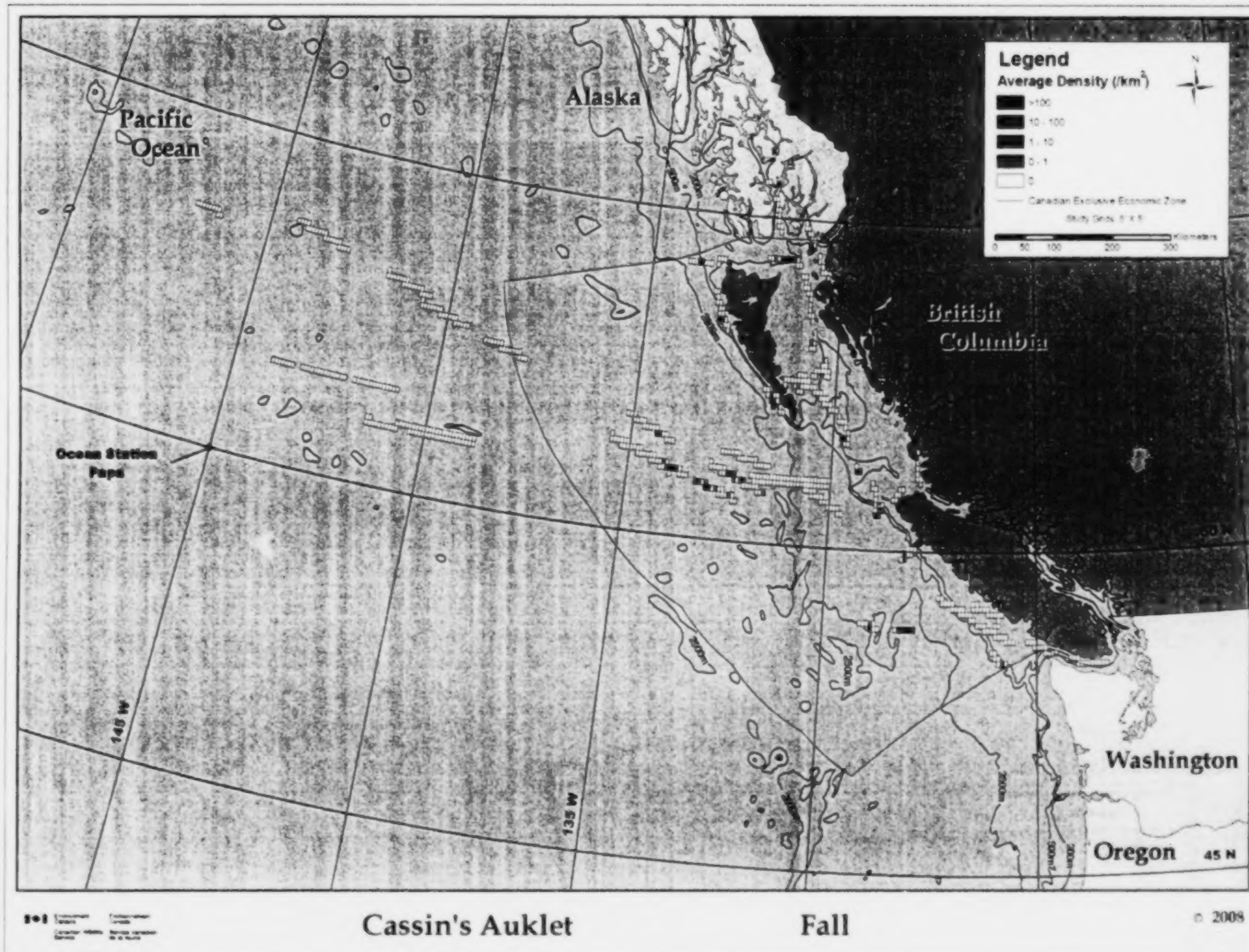

Figure 46C. Seasonal average grid cell densities of Cassin's Auklets.

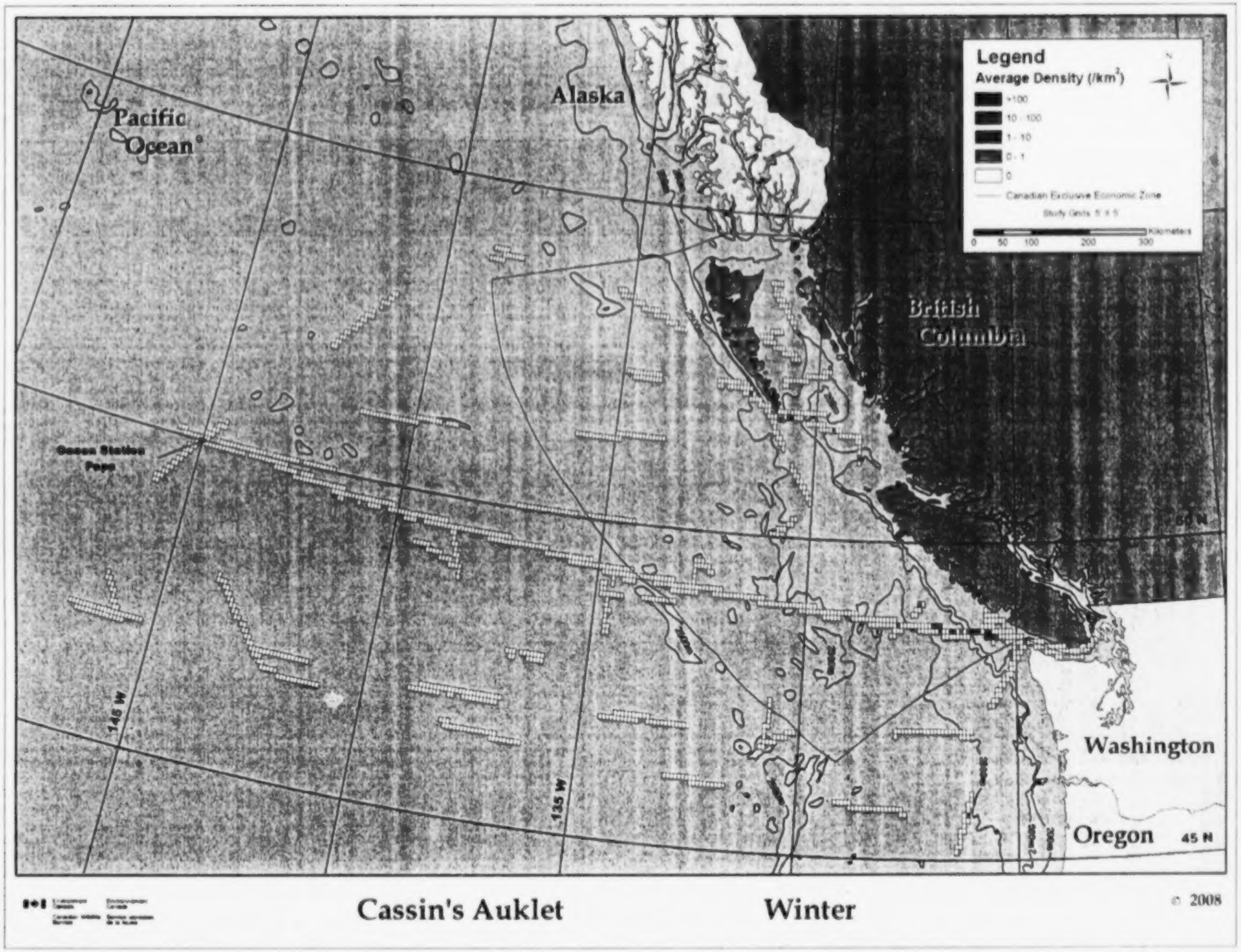

Figure 46D. Seasonal average grid cell densities of Cassin's Auklets.

3.1.9.7 Cassin's Auklet *Ptychoramphus aleuticus*

3.1.9.7.1 Population and Conservation Status

The world population of Cassin's Auklets is estimated to be as high as five million individuals (Manuwal and Thoresen 1993, BirdLife International 2008). Although there are indications of regional declines in the number of nesting Cassin's Auklets, they are considered by the IUCN globally as a species of *Least Concern* (BirdLife International 2008).

3.1.9.7.2 Breeding Distribution and Chronology

One of the most widespread of the Pacific alcids, Cassin's Auklets breed from Buldir Island east and south along the coasts of AK, BC, WA, OR, and CA to approximately central Baja California (Harrison 1983, Manuwal and Thoresen 1993, Gaston and Jones 1998). BC supports approximately 75% of the breeding population (Manuwal and Thoresen 1993) and because of the global significance of this provincial population, Cassin's Auklets are Blue-listed in BC (BCCDC 2006). Triangle Island is the world's largest colony, supporting about 2.8 million Cassin's Auklet (Gaston and Jones 1998).

There is much variation in the timing of breeding of Cassin's Auklets. At the southern end of their range, the earliest breeding begins in late November and extends over a protracted period lasting up to six months (Jehl and Everett 1985). In comparison, on Triangle Island, egg-laying occurs from late March to late April; and, fledging and colony dispersal generally occurs throughout July to early August (Vermeer 1987).

3.1.9.7.3 Oceanic Distribution and Diet

Southern populations of Cassin's Auklets are believed to be sedentary, whereas northern (BC and AK) birds apparently disperse to more southern waters (Manuwal and Thoresen 1993). However, Campbell *et al.* (1990b) suggested that Cassin's Auklets overwinter from southern BC to Baja California. Briggs *et al.* (1987) estimated between 500,000 and one million Cassin's Auklets were present off the CA coast during fall; many of those birds likely originated from BC and AK. Cassin's Auklets are found primarily over the shelfbreak/slope region, and occasionally well offshore; off CA they apparently prefer to forage in coastal upwellings over the shelf during spring and summer, but many feed as far as 150 km offshore in fall and winter (Briggs *et al.* 1987). They are found throughout the year in WA waters, and are classed as a variably common to abundant breeder on the outer coast, a resident and offshore migrant, and rare to uncommon

visitor to inland waters. They are most numerous along the outer coast from mid-February to early April and late August to November (Wahl *et al.* 2005).

The diet of Cassin's Auklets varies geographically, and most of what is known is based on samples of food brought back to the young. In BC invertebrate prey includes: calanoid copepods (e.g., *Neocalanus cristatus, N. plumchrus, Metridia pacifica*), euphausiids (e.g., *Thysanoessa longipes, T. spinifera, Euphausia pacifica*), hyperiid amphipods (e.g., *Parathemisto pacifica, Primno macropa*), caridean and brachyuran larvae, small pandalid shrimp, cirripeds, ctenophores, decapods and immature squid (Vermeer *et al.* 1985, Burger and Powell 1990). They are also known to prey upon juvenile fish (e.g., Irish lord, rockfish species, Pacific sandlance, sanddab) (Vermeer *et al.* 1987c, Burger and Powell 1990, Manuwal and Thoresen 2003).

3.1.9.7.4 Spatial Distribution and *Average Grid Cell Density* in Study Area

Cassin's Auklets were present year-round in BC waters. During spring, the highest *average grid cell densities* of Cassin's Auklets (10.0-100.0 birds/km^2) were along the slope region (water depth 500-2,500 m), 50-75 km northwest to southwest of Triangle Island. Areas of high density also included the eastern edge of Cook Bank, the approach to Queen Charlotte Sound and west of Graham Island. Lower *average grid cell densities* (1.0-10.0 birds/km^2) were located in Hecate Strait, and along most of the outer shelf and seaward to the west of Vancouver Island. Two very large groups of Cassin's Auklets were encountered during spring (both on 1 June 2003); a flock with an estimated 800 auklets was observed approximately 90 km west of Quatsino Sound, and another group estimated at 750 birds, was seen roughly 62 km south-southwest of Cape Scott. While most Cassin's Auklets were encountered within 100 km of land during spring, they were also found well offshore. In May 1982, a bird was seen about 60 km northeast of OSP, or roughly 855 km from the nearest land. On 10 June 2003, two Cassin's Auklets were observed approximately 415 km west of Langara Island.

There were fewer summer observations of Cassin's Auklets than during spring; the highest *average grid cell density* (51.5 birds/km^2) was located west of Langara Island. They were also encountered at high densities (10.0-100.0 birds/km^2) west of Triangle Island, and west of the Olympic Peninsula. Lower densities of auklets were also scattered from west of Iphigenia Bay in the north to west of the Olympic Peninsula, as well as inside Juan de Fuca Strait. Based on where radio-tagged Cassin's Auklets from Triangle Island were detected at sea, McFarlane Tranquilla *et al.* (2005a) stated that breeding birds generally traveled between 40 and 70 km and up to 113

km from the colony during chick-rearing. Although we do not know the breeding status of the birds observed in this study, all Cassin's Auklets encountered in the summer months were within 113 km of the nearest land. The largest group of Cassin's Auklets we observed during summer (260 birds) was found on 26 June 1994, about 85 km northwest of Triangle Island.

There were fewer fall observations of Cassin's Auklets than during spring or summer, and all *average grid cell densities* were <7.0 birds/km^2. Birds were scattered throughout the study area; although most birds were found seaward of the shelfbreak. The farthest offshore a Cassin's Auklet was observed was approximate 230 km from land.

During winter months, Cassin's Auklets were very restricted (spatially and numerically); the maximum *average grid cell density* was only 2.2 birds/ km^2. They were encountered primarily in two areas: Queen Charlotte Sound and off the southwest coast of Vancouver Island. Cassin's Auklets were seen from the west coast of Moresby Island to approximately 175 km west, southwest of the mouth of the Columbia River.

Cassin's Auklet is considered a common to abundant summer visitor, locally very abundant near the colonies, and fairly common to locally common along the northern mainland coast; in winter, casual on the north coast, uncommon to fairly common on the west coast of Vancouver Island and Juan de Fuca Strait (Campbell *et al.* 1990b).

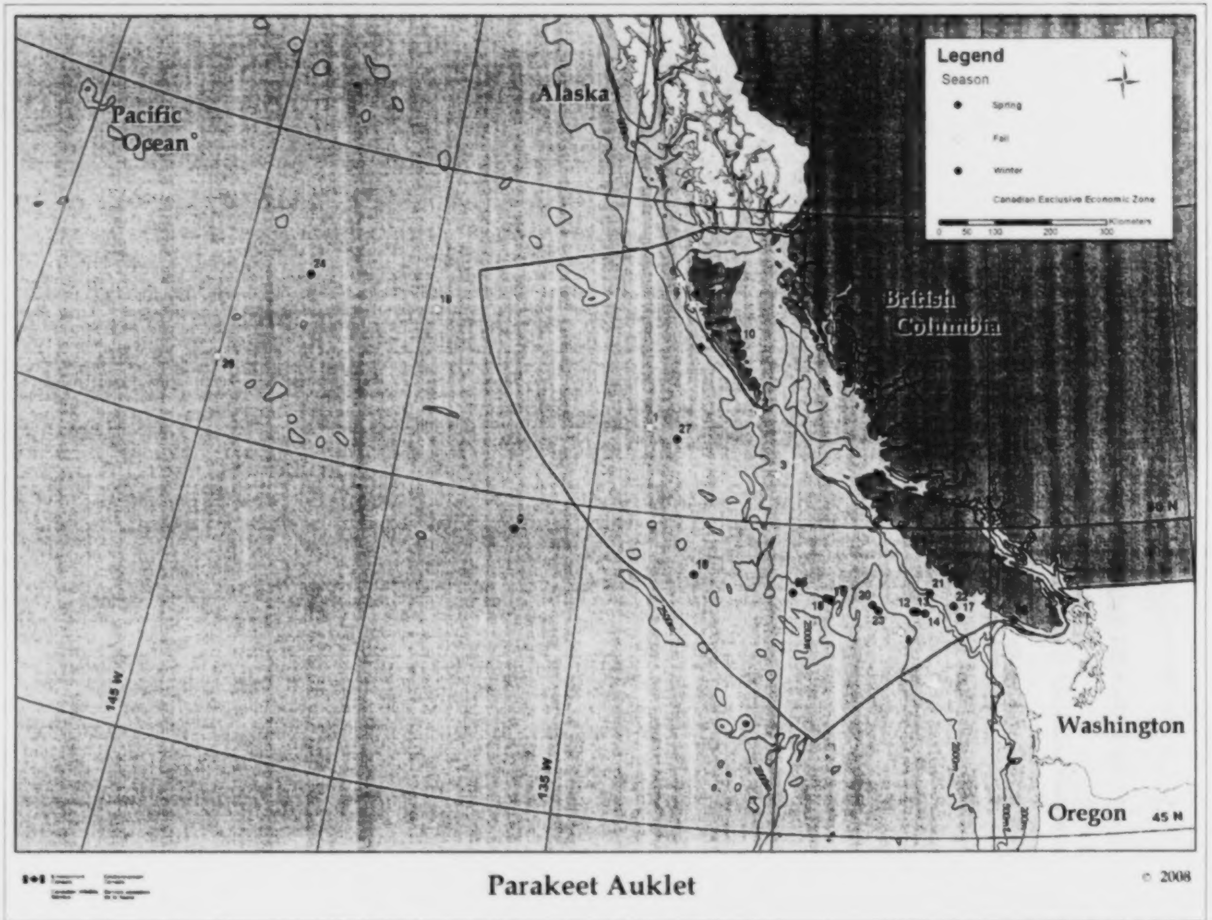

Figure 47. Locations where Parakeet Auklets have been observed.

See Appendix 1 for details.

3.1.9.8 Parakeet Auklet *Aethia psittacula*

3.1.9.8.1 Population and Conservation Status

With a global population estimated at 800,000 birds, the IUCN lists the Parakeet Auklet as a species of *Least Concern* (BirdLife International 2008). Kushlan *et al.* (2002) ranked it as a species of *Low Conservation Concern* for N America.

3.1.9.8.2 Breeding Distribution and Chronology

Parakeet Auklets breed from Cape Lisburn, Bering Strait, south through the Bering Sea to the Aleutian Islands, west to the Commander Islands and east to Prince William Sound (Harrison 1983, Gaston and Jones 1998).

Breeding birds return to their colonies in April or May, eggs are laid during June - August and fledging and dispersal takes place in late August to early September (Harrison 1983, Jones *et al.* 2001).

3.1.9.8.3 Oceanic Distribution and Diet

Although it has been reported that they may remain in ice-free areas within their breeding range (Sowls *et al.* 1978), it is likely that most Parakeet Auklets overwinter to the south, including occasionally as far south as Japan and CA (Harrison 1983). Day (2006) reported that Parakeet Auklets were seen in the northern GOA on the shelf as well as offshore to approximately 185 km from land. Of 15 sightings of Parakeet Auklets in WA accepted by the WA Bird Record Committee, all but one has occurred between mid-December and 25 April; the exception was of a bird (reported by Roberson 1980) seen off Westport on 18 July 1986 (Wahl *et al.* 2005).

Parakeet Auklets prey upon comb jellies (Ctenophores), scyphozoan jellies, euphausiids (e.g., *Thysanoessa inermis*), calanoid copepods (e.g., *Neocalanus cristatus*), amphipods (e.g., *Parathemisto libellula*), small squid, and larval fish. (Hunt *et al.*1981, Hunt *et al.*1998).

3.1.9.8.4 Distribution in Study Area

Parakeet Auklets were observed in the study area on 28 occasions. The majority of the sightings (approximately 39%) occurred in February and October (25%). Most birds were seaward of the shelfbreak off southwest Vancouver Island, and all but three sightings were within Canada's EEZ. The farthest offshore we observed a Parakeet Auklet was roughly 650 km from land, seen on 4 April 2004. Contrasting that was the sighting of a Parakeet Auklet <150 m from shore, near the entrance to Juan de Fuca Strait on 14 December 2007 (R. Toochin, pers. comm.). Consistent with Gaston and Jones (1998), almost all observations of Parakeet Auklets were of single

individuals; only four sightings consisted of more than one bird, and the largest group size was four.

Campbell *et al.* (1990b) lists single observer sightings of three Parakeet Auklets on 24 February 1971, approximately 24 km southwest of Estevan Point. Because they were single observer sightings the authors listed the species as hypothetical within BC. The first accepted Canadian record of Parakeet Auklets occurred on 13 May 1993, when three birds were seen southwest of Reef Island (Sirois and Butler 1994). Following the Nestucca oil spill off the WA coast (on 23 December 1988), 15 Parakeet Auklets were amongst the 3,137 birds found along the west coast of Vancouver Island, between 3 January and 8 February 1989 Campbell *et al.* (1990b). These sightings of oiled birds in winter are consistent with our data which suggests a higher number of Parakeet Auklets in BC waters in winter (i.e., 43% of all sightings, or 45% of the total birds seen, occurred between mid-December and late February).

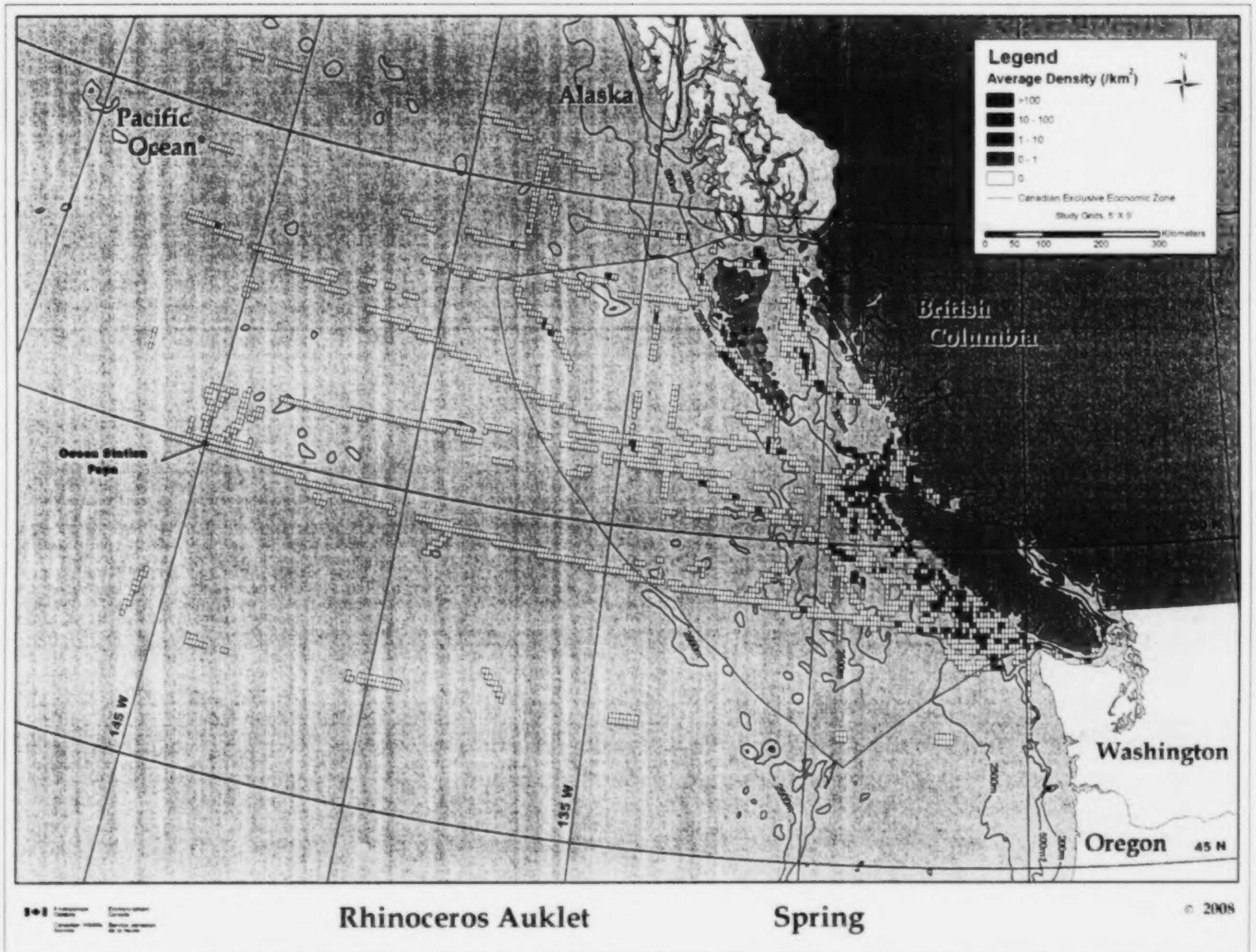

Figure 48A. Seasonal average grid cell densities of Rhinoceros Auklets.

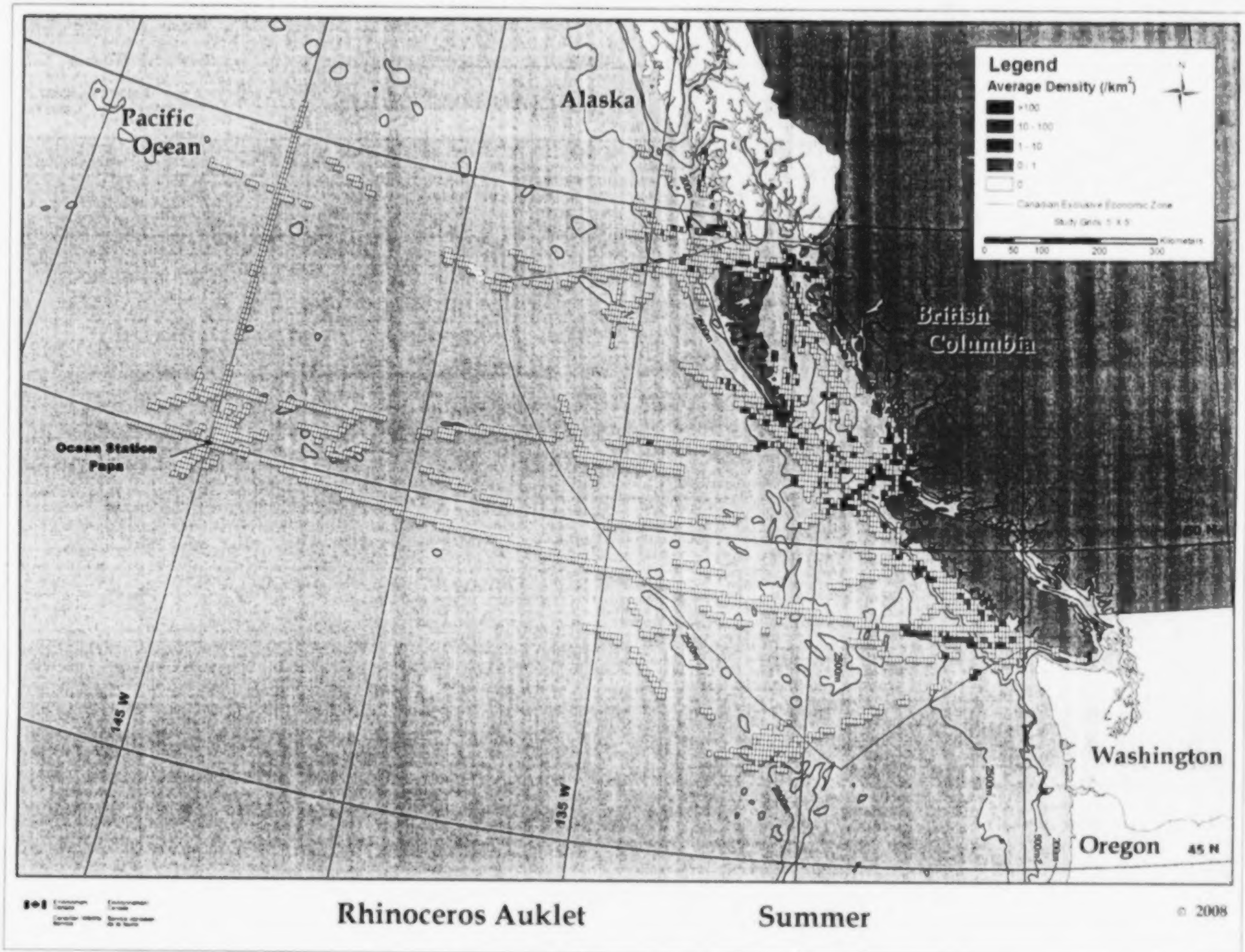

Figure 48B. Seasonal average grid cell densities of Rhinoceros Auklets.

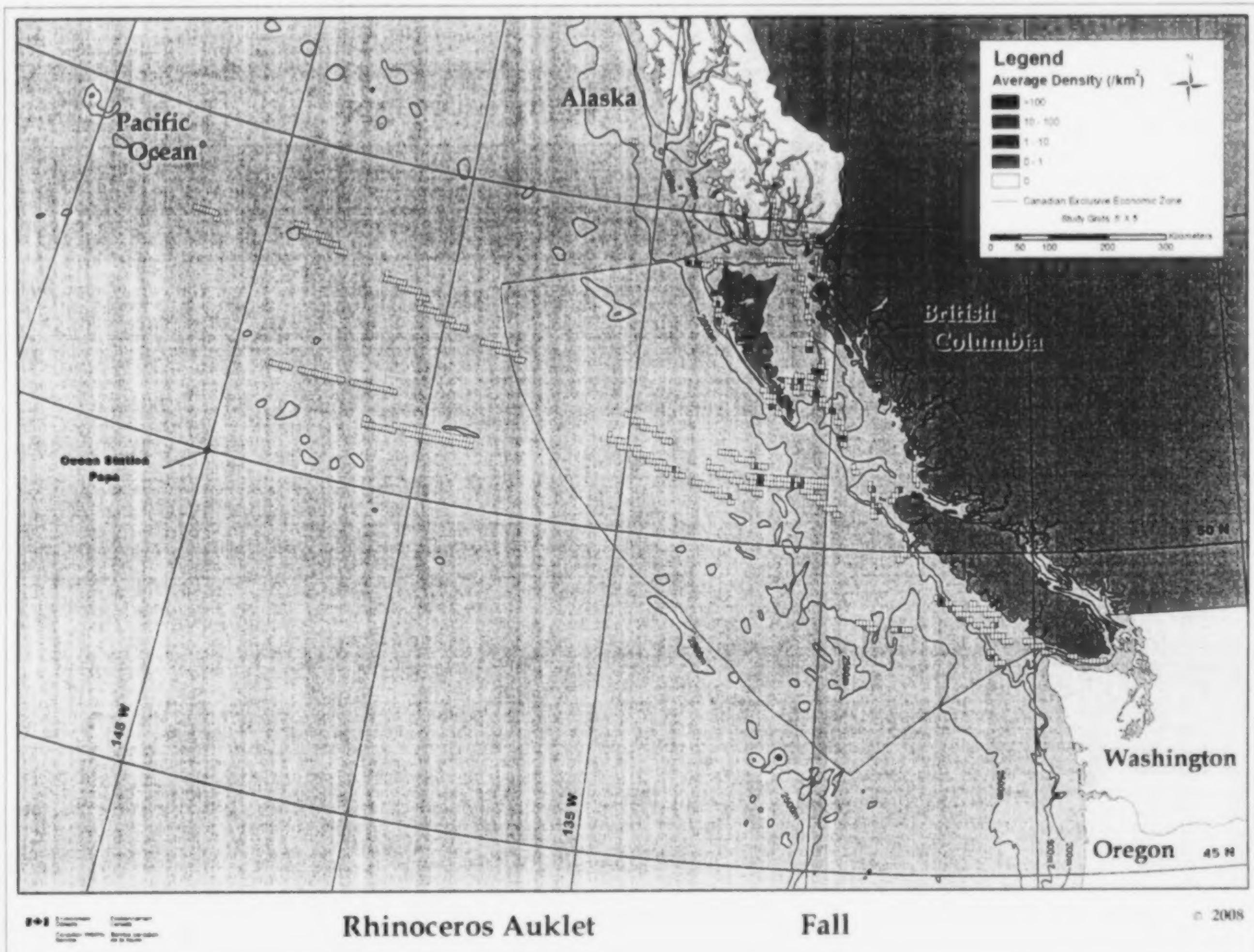

Figure 48C. Seasonal average grid cell densities of Rhinoceros Auklets.

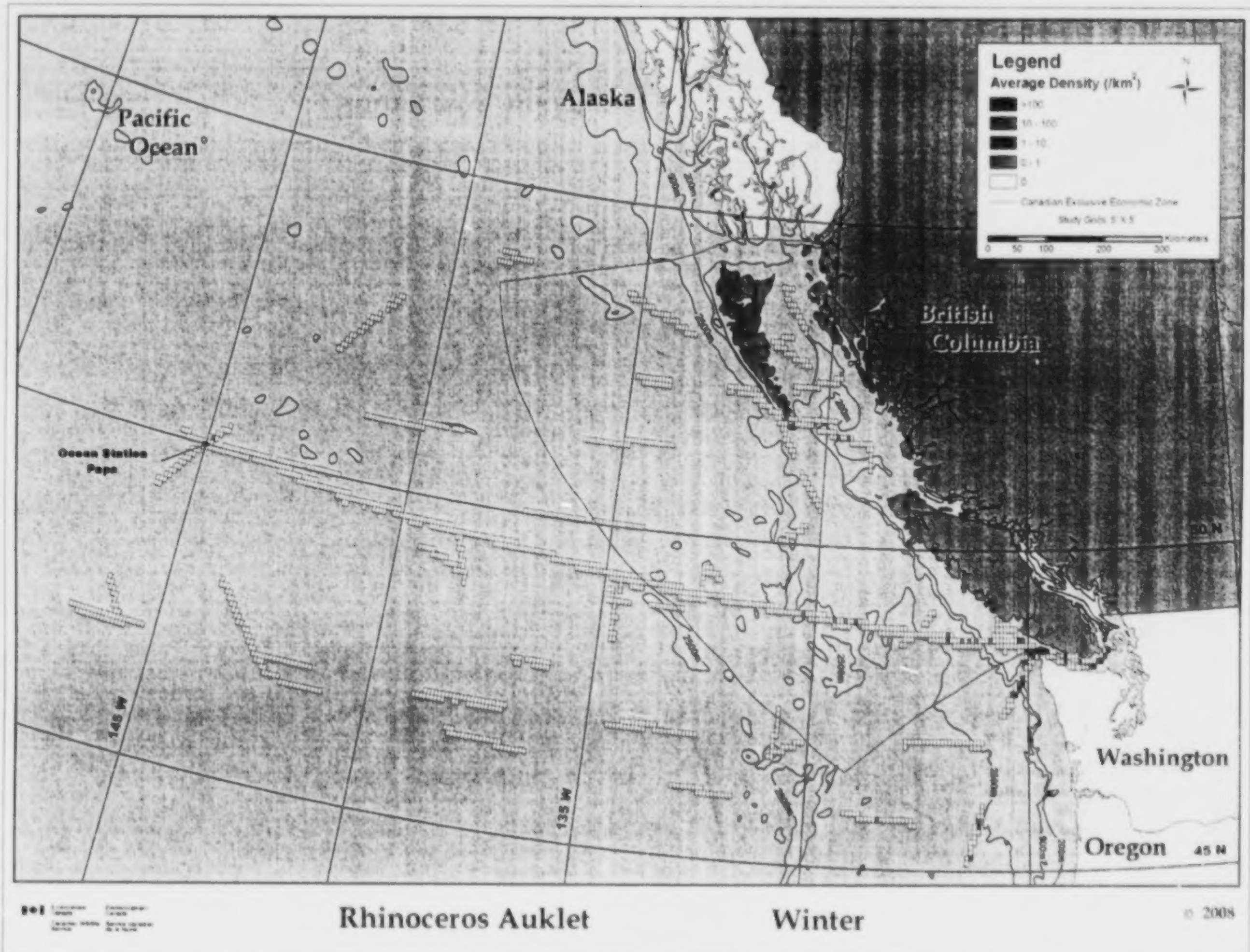

Figure 48D. Seasonal average grid cell densities of Rhinoceros Auklets.

3.1.9.9 Rhinoceros Auklet *Cerorhinca monocerata*

3.1.9.9.1 Population and Conservation Status

With an estimated two to three million birds worldwide (Gaston and Dechesne 1996), the Rhinoceros Auklet is listed as a species of *Least Concern* by the IUCN (BirdLife International 2008). In N America and Canada, it is listed as a species of *Low Conservation Concern* (Kushlan *et al.* 2002, Milko *et al.* 2003) respectively.

3.1.9.9.2 Breeding Distribution and Chronology

Rhinoceros Auklets breed from Korea, Japan, Sakhalin, Kuril and Aleutian Islands to southern AK, and south to CA. The largest breeding colony of Rhinoceros Auklets is on Teuri Island, Japan, where an estimated 350,000 birds occur (Watanuki 1987). In N America, the largest colonies are located in WA, BC, and southeast AK (Gaston and Dechesne 1996, Gaston and Jones 1998). Rodway (1991) states that this species nests at 35 sites within BC, with six colonies accounting for >85% of the provincial total (Pine Island, Storm Islet, Triangle Island, Moore Island, Byers Island, and Lucy Island).

3.1.9.9.3 Oceanic Distribution and Diet

Rhinoceros Auklets are generally found over the continental shelf (Gaston and Dechesne 1996) or seaward of the shelfbreak (Briggs *et al.* 1987), where they tend to associate with steep sea surface temperature gradients (O'Hara *et al.* 2006).

In WA, the Rhinoceros Auklet is a common to locally abundant summer resident on the outer coast, offshore and northern inland waters, and a fairly common to common winter resident on the outer coast and southern inland waters. They are observed in WA in all months (Wahl *et al.* 2005). In CA, Rhinoceros Auklets are abundant in offshore waters the length of the state in winter. An estimated 200,000 to 300,000 birds occupy CA waters in winter, suggesting that a large proportion of the eastern N Pacific Rhinoceros Auklet population occurs off CA, especially in February and March (Briggs *et al.* 1987).

The prey of Rhinoceros Auklets includes small squid, a wide variety of fish (e.g., capelin, eulachon, lingcod, myctophids, northern anchovy, ocean perch, Pacific cod, Pacific herring, Pacific sandlance, Pacific saury, salmon), copepods and euphausiids (Bertram and Kaiser 1988, DeGange and Sanger 1986, Gaston and Jones 1998, Hatch and Sanger 1992, Vermeer 1992, Vermeer and Westrheim 1984, Vermeer *et al.* 1987c, M. Hipfner, unpubl. data 2008).

3.1.9.9.4 Spatial Distribution and *Average Grid Cell Density* in Study Area

Rhinoceros Auklets were present in all seasons, but were particularly abundant during spring and summer. During spring, Rhinoceros Auklets were numerous over the shelfbreak/slope region, although they were encountered well offshore. The farthest from land a Rhinoceros Auklet was encountered during this season was approximately 780 km. Birds were generally well distributed (0.1-1.0 birds/km^2 and 1.0-10.0 birds/km^2) throughout Hecate Strait, eastern Dixon Entrance, Queen Charlotte Sound, and along the west coasts of Moresby and Vancouver Islands. The highest springtime *average grid cell densities* (15.0-21.0 birds/km^2) were located between Nigei and Hope Islands and Smith Sound (within <50 km of the major breeding colonies on Pine Island and Storm Islet). The largest group of Rhinoceros Auklets observed in spring consisted of 124 birds, seen on 30 May 1998 west of Hunter Island.

The highest Rhinoceros Auklet *average grid cell densities* occurred during summer, particularly in two locations: near the Scott Islands especially over Cook Bank (68.0 birds/km^2); and in central Dixon Entrance (83.4 birds/km^2). The largest summer aggregation (96 birds) was seen near Prince Rupert (on 9 July 2000); many of those birds were likely from the colony at Lucy Island. Moderate *average grid cell densities* (1.0-10.0 birds/km^2) were located near Forrester Island (largest Rhinoceros Auklet colony in AK, Sowls *et al.* 1978), off the southern end of Moresby Island and throughout Hecate Strait and Queen Charlotte Sound. Rhinoceros Auklets occurred at predominantly low *average grid cell densities* off the west coast of Vancouver Island. Birds were closer to land during summer, with all birds seen within 220 km of the coast. Gaston and Jones (1998) stated that during the breeding season Rhinoceros Auklets are generally found closer to shore than during the rest of the year.

There were relatively few fall sightings of Rhinoceros Auklets, and most *average grid cell densities* were <1.0 bird/km^2. Birds were encountered primarily along the outer shelf, or over the shelfbreak/slope regions, along the west coast of Vancouver Island, the west coast of Graham Island, the southeast and southwest coasts of Moresby Island, and in Hecate Strait. They were also found offshore, out to about 210 km from the nearest land. The highest fall *average grid cell density* (15.6 birds/km^2) occurred approximately 50 km west of Langara Island.

In contrast to what was observed by Morgan *et al.* (1991), Rhinoceros Auklets were seen relatively frequently during winter months, and mostly around southern Vancouver Island. Very few Rhinoceros Auklets were seen north of 50° N; only three birds were encountered at the

shelfbreak in Queen Charlotte Sound (on 16 February 2000). Winter densities were highest in Juan de Fuca Strait, especially near Cape Flattery. The farthest offshore Rhinoceros Auklets were seen during winter was approximately 10 km northeast of OSP, more than 900 km from the nearest land.

Rhinoceros Auklets are present in BC waters all year long; they are a common to abundant spring migrant along the outer coast, rare in inner coastal waters, locally common to very abundant summer visitor along the coast other than the Strait of Georgia (where it is uncommon), very rare on the north coast and west coast of Vancouver Island in winter, rare in the northern Strait of Georgia and uncommon to fairly common in the Gulf Islands and Juan de Fuca Strait (Campbell *et al.* 1990b).

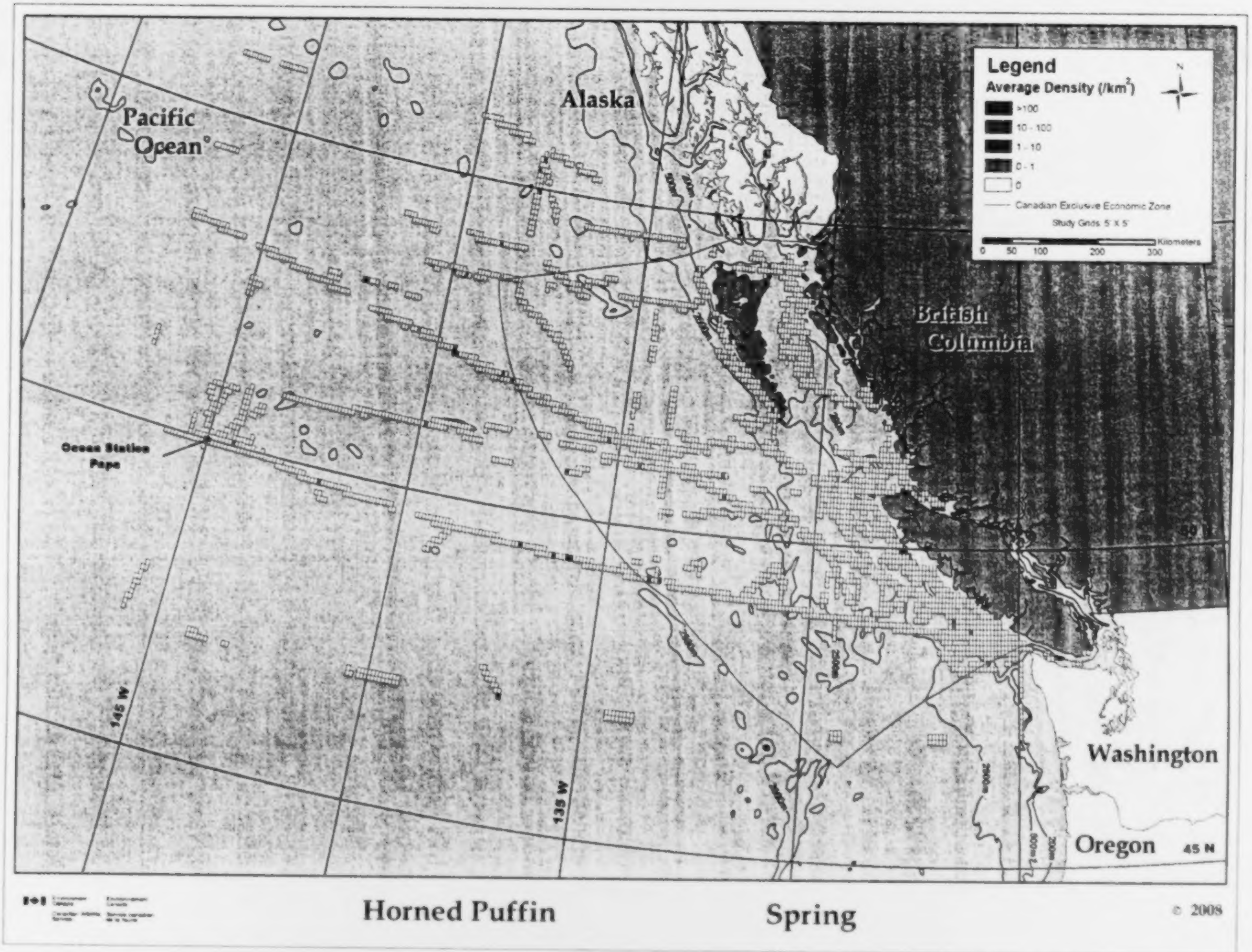

Figure 49A. Seasonal average grid cell densities of Horned Puffins.

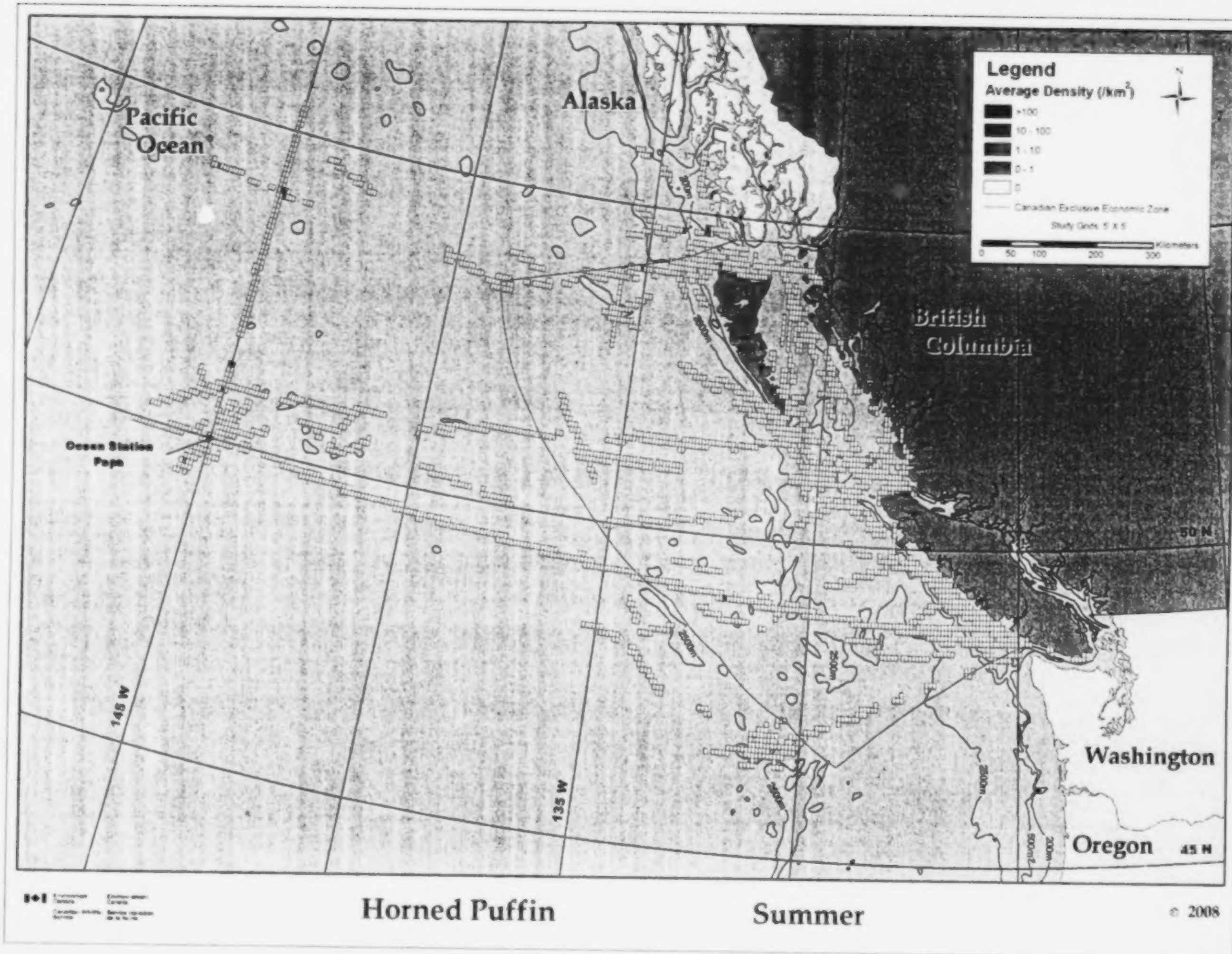

Figure 49B. Seasonal average grid cell densities of Horned Puffins.

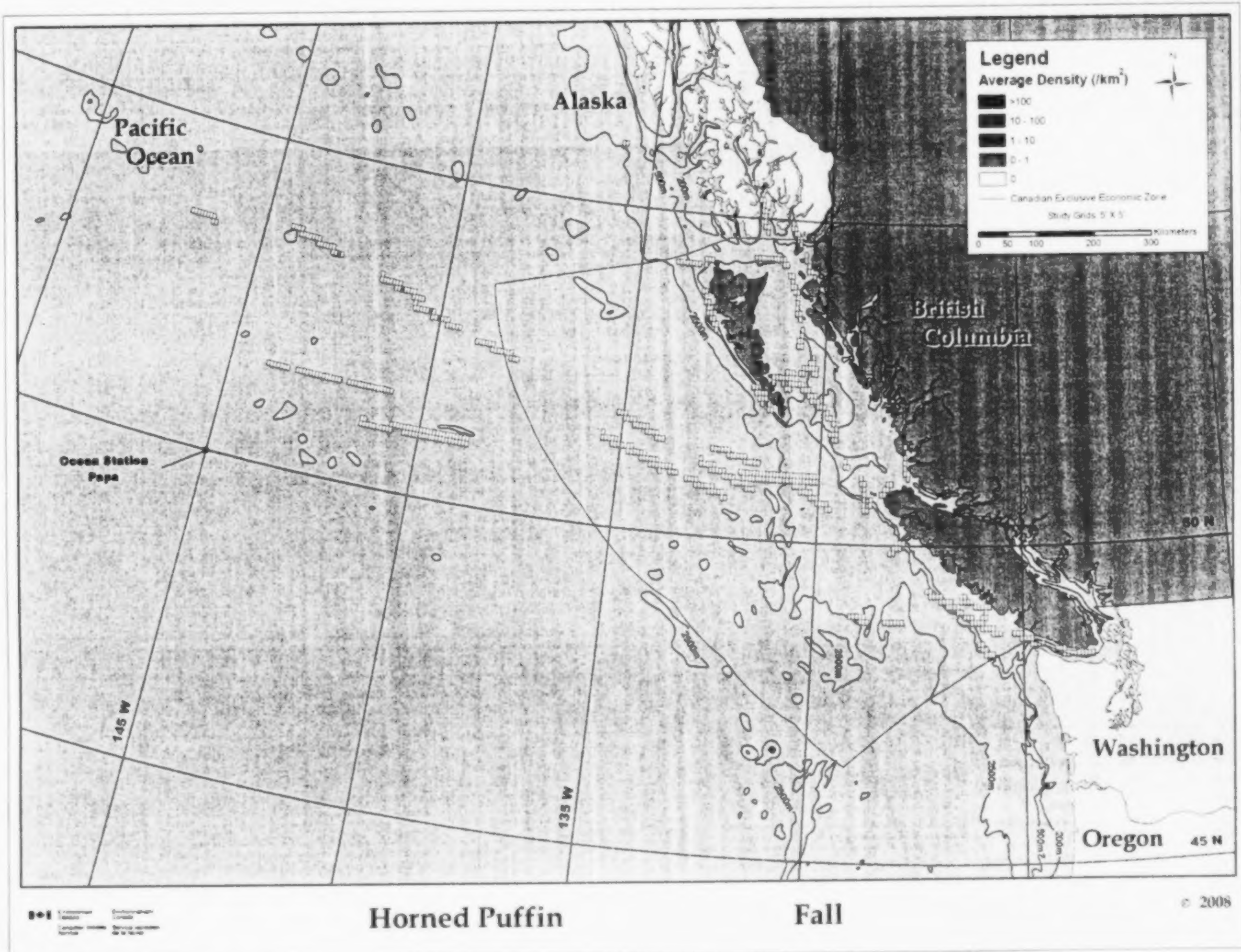

Figure 49C. Seasonal average grid cell densities of Horned Puffins.

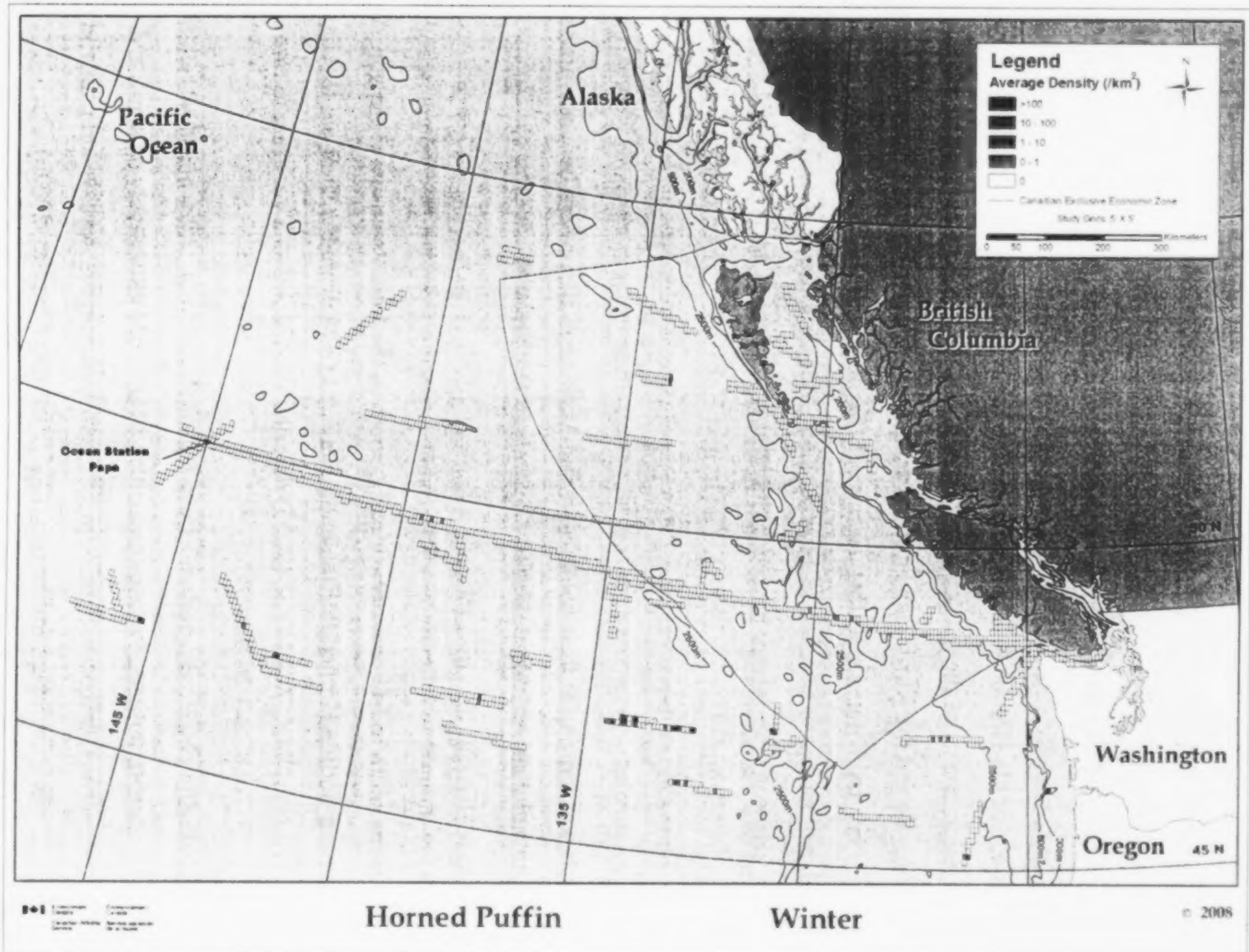

Figure 49D. Seasonal average grid cell densities of Horned Puffins.

3.1.9.10 Horned Puffin *Fratercula corniculata*

3.1.9.10.1 Population and Conservation Status

With an estimated global breeding population of approximately 1.2 million birds, the IUCN considers the Horned Puffin to be a species of *Least Concern* (BirdLife International 2008). The Horned Puffin is listed as a species of *Moderate* and *High Conservation Concern* for N America and Canada Kushlan *et al*. 2002 and Milko *et al.* 2003, respectively). In addition, the Horned Puffin is on the BC provincial *Red List* (BCCDC 2006).

3.1.9.10.2 Breeding Distribution and Chronology

The breeding range of the Horned Puffin is restricted to the N Pacific; they breed along the Siberian and Alaskan coasts of the Chukchi Sea; throughout the Bering Sea south to the Kamchatka Peninsula and the Kuril Islands; south and east to Glacier Bay and Forrester Island (Harrison 1983, Piatt and Kitaysky 2002a). Horned Puffin nesting in BC has been confirmed for Anthony Island, and they may also nest at 11 other sites, including the Kerouard Islands, Triangle Island, and Solander Island; however, the total BC breeding population is likely no larger than 25 pairs (Campbell *et al.* 1990b). The largest Horned Puffin colonies are located on Suklik Island (about 250,000 birds,) and on Talan Island (Sea of Okhotsk) where an estimated 120,000 birds breed (Sowls *et al.* 1978, Gaston and Jones 1998, Piatt and Kitaysky 2002a). Horned Puffins begin arriving at their colonies in mid-May, eggs are present between June and July and fledging and dispersal takes place in September/October.

3.1.9.10.3 Oceanic Distribution and Diet

Horned Puffins are thought to overwinter well offshore, ranging from ice-free waters near their main breeding areas south to BC; and occasionally, south to the Baja Peninsula (Harrison 1983). Day (2006) reported finding Horned Puffins in the northern GOA from the shelf out to approximately 210 from land. Wahl *et al.* (2005) describe the species as a very rare to rare visitor to WA's outer coast and inland marine waters.

Although Horned Puffin chicks are predominantly fed small fish (e.g., Atka mackerel, white-spotted greenling capelin, pollock, Pacific sandlance), adults feed extensively on squid and miscellaneous crustaceans, and occasionally on gammarid amphipods, mysids and pandalid shrimp (Hunt *et al.* 1981, DeGange and Sanger 1986, Piatt and Kitaysky 2002a). Horned Puffins often forage in mixed feeding groups, diving to an average depth of 30 m (Piatt and Kitaysky 2002a).

3.1.9.10.4 Spatial Distribution and *Average Grid Cell Density* in Study Area

Within the study area, Horned Puffin were scattered very widely at very low density in all seasons. Although occasionally found over the shelf, most Horned Puffins were encountered well offshore.

The maximum Horned Puffin *average grid cell density* (<1.6 birds/km^2) occurred during spring. Although this species was encountered close to two of the suspected colonies (Solander Island and the Kerouard Islands), the remaining spring observations were well beyond the shelf/slope region. They were widely distributed (from about 55.5° N to 47.1° N), and out to approximately 870 km from the nearest land.

Only 15 Horned Puffins were encountered during summer surveys, with most birds seen north of 50° N, and only two within the Canadian EEZ. Five observations occurred near Forrester Island, where Horned Puffins nest. Birds were seen out to approximately 960 km from land.

There were even fewer observations of Horned Puffins during fall; only four birds were encountered and all outside of Canada's EEZ. They were found between 480 and 600 km from the nearest land.

Horned Puffins were relatively common and widespread during winter surveys. However, most birds were seen outside of Canada's EEZ and with one exception, all sightings were from south of 50° N. Most sightings were of individual birds, the largest group encountered, consisting of five birds, was seen (on 22 February 2005) about 165 km west of Cobb Seamount.

According to Campbell *et al*. (1990b), Horned Puffins have been reported between 25 February and 19 November, and are considered to be a rare migrant, locally uncommon to fairly common summer visitor and casual in winter along the outer coast. The vast majority (> 90%) of Horned Puffins reported in BC have been seen between May and the end of August.

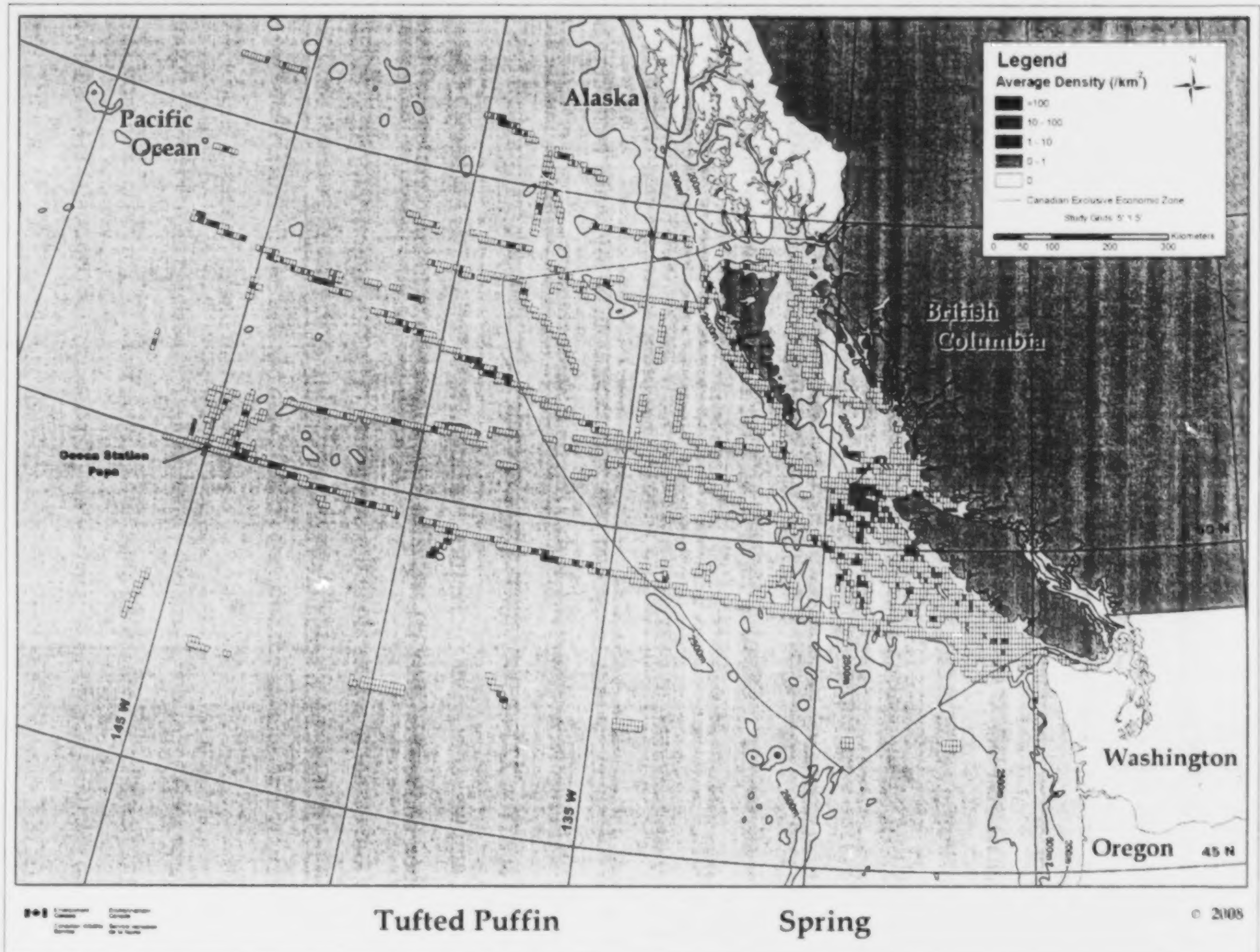

Figure 50A. Seasonal average grid cell densities of Tufted Puffins.

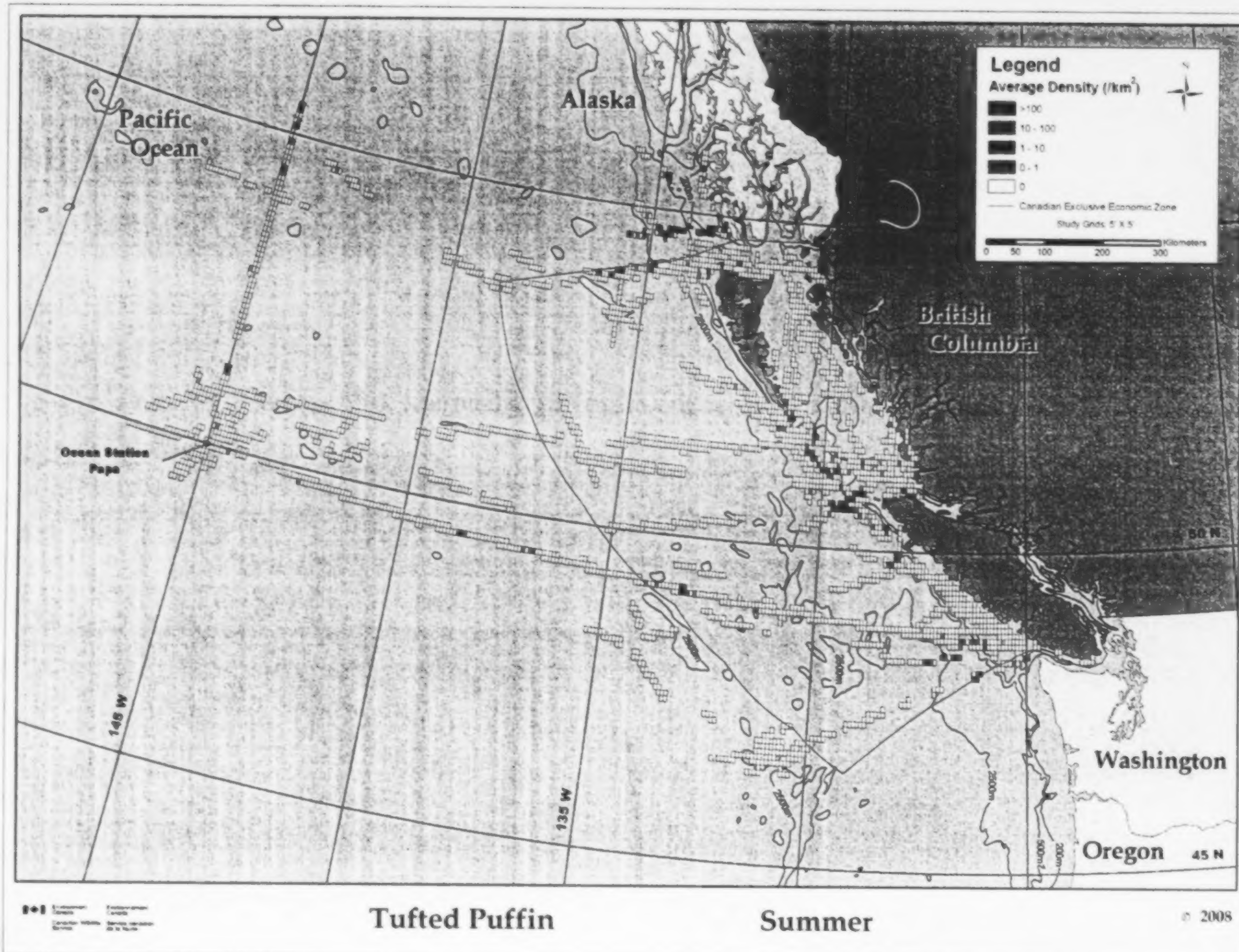

Figure 50B. Seasonal average grid cell densities of Tufted Puffins.

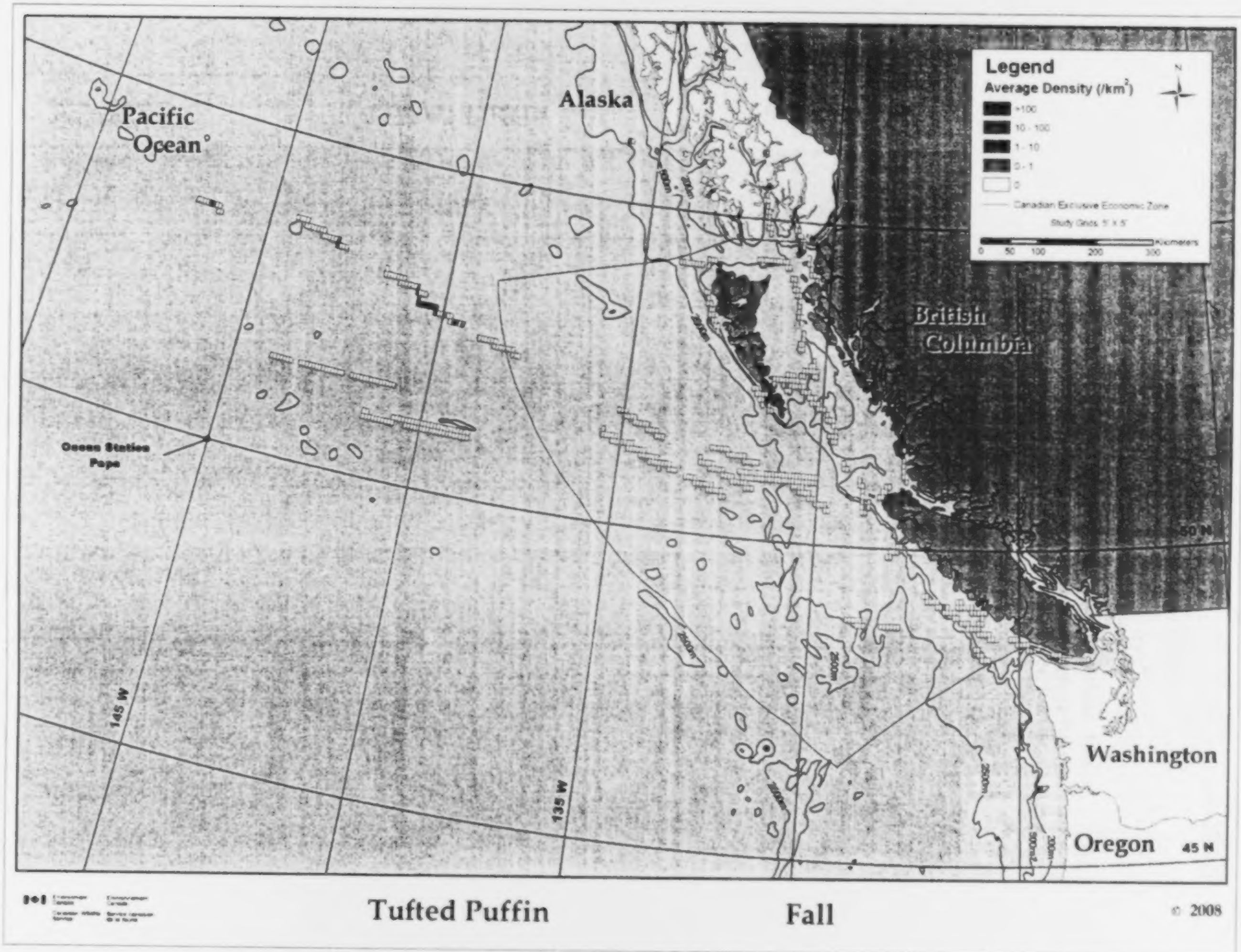

Figure 50C. Seasonal average grid cell densities of Tufted Puffins.

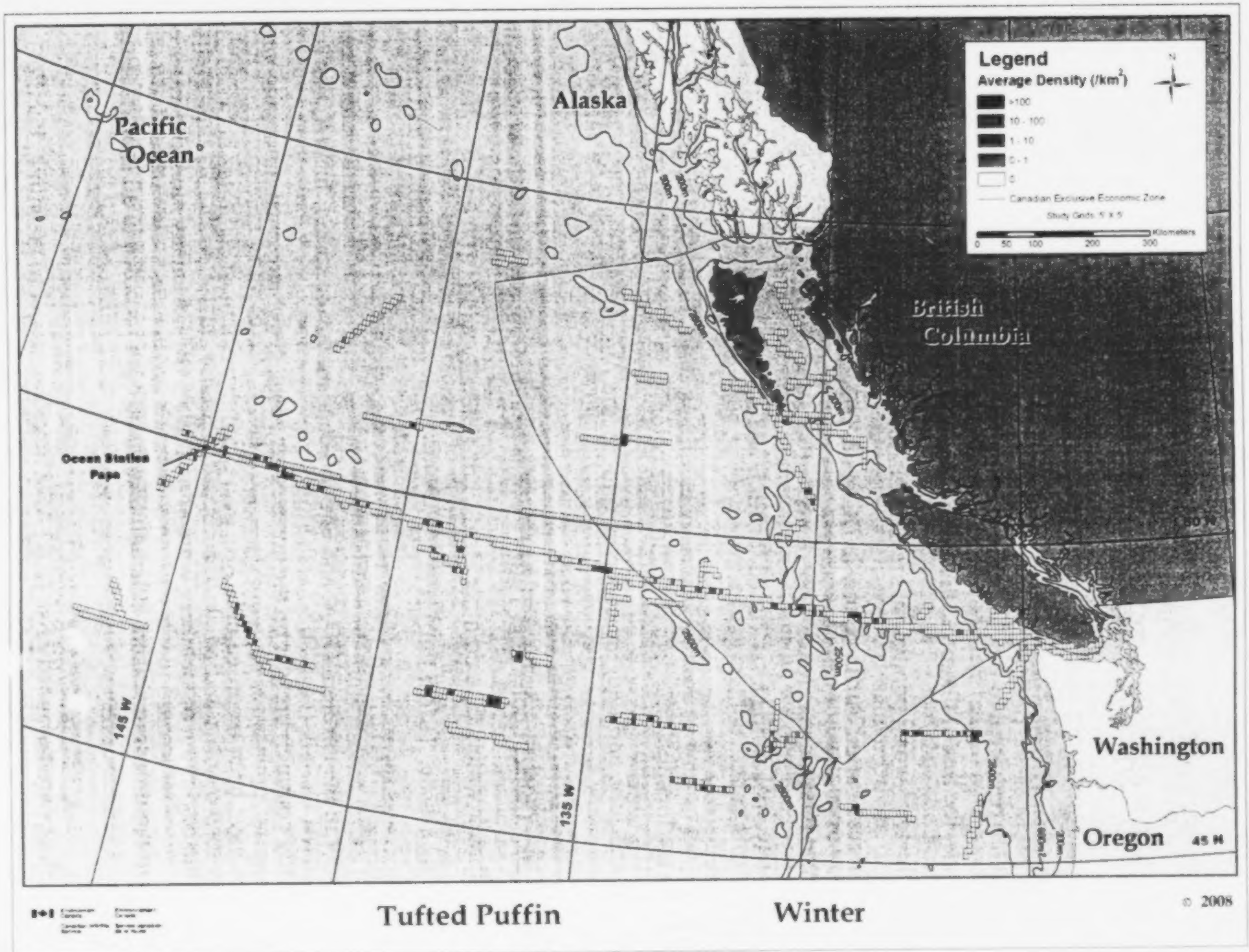

Figure 50D. Seasonal average grid cell densities of Tufted Puffins.

3.1.9.11 Tufted Puffin *Fratercula cirrhata*

3.1.9.11.1 Population and Conservation Status

The world population of Tufted Puffins is estimated at 2.97 million birds (Piatt and Kitaysky 2002b). They are considered by the IUCN to be a species of *Least Concern* globally (BirdLife International 2008). The Tufted Puffin is listed as a species of *Low Conservation Concern* in N America (Kushlan *et al.* 2002), and of *Moderate Conservation Concern* in Canada (Milko *et al.* 2003).

3.1.9.11.2 Breeding Distribution and Chronology

Tufted Puffins are restricted to the N Pacific, nesting NE Siberia and Cape Lisburn south through the Kuril Islands, the Sea of Okhotsk, the Bering Sea and the Aleutians to CA. About 80% of the colonies and the total world population breed in N America (Harrison 1983, Piatt and Kitaysky 2002b). The largest Tufted Puffin colony in BC is on Triangle Island, where approximately 50,000 birds nest (Gaston and Jones 1998, Piatt and Kitaysky 2002b). The Scott Islands account for approximately 90% of the total Tufted Puffin breeding population in BC, and Solander Island supports an estimated 8%.

Depending on the location, breeders return to their colonies in April or May, eggs are laid between May and July, and fledging occurs in mid- to late August (Piatt and Kitaysky 2002b).

3.1.9.11.3 Oceanic Distribution and Diet

Piatt and Kitaysky (2002b) noted that Tufted Puffins tend to forage more offshore in continental shelf and shelfbreak waters than do other alcids, but generally within 100 km of colonies. During the non-breeding season, Tufted Puffins move offshore into true pelagic habitat, and range to as far south as about 35° S (Harrison 1983). Day (2006) described the Tufted Puffin as a rare fall and winter visitor in the northern GOA, and rare to abundant during spring. In WA, the Tufted Puffin is a locally common breeder on the north outer coast, elsewhere uncommon and very rare in winter. They have been recorded in WA in every month, with most sightings between the end of March and the beginning of October (Wahl *et al.* 2005). Off CA, many more puffins are seen in winter than in the breeding season, although they have been recorded in all months (Briggs *et al.* 1987).

Tufted Puffin chicks are fed mostly fish (e.g., Atka mackerel, capelin, greenling, Pacific sandlance, Pacific saury, Pollock, rockfish species, sablefish); while adults eat squid, polychaetes, euphausiids, gammarid amphipods, mysids and pandalid shrimp as well (Vermeer

and Westrheim 1984, DeGange and Sanger 1986, Vermeer 1992, Gaston and Jones 1998, Piatt and Kitaysky 2002b).

3.1.9.11.4 Spatial Distribution and *Average Grid Cell Density* in Study Area

Tufted Puffins were found scattered widely throughout the study area. They were encountered west of OSP, and from approximately 56° N south to roughly 46° N. Similar to that found by Morgan *et al.* (1991), Tufted Puffins were observed mostly seaward of the shelfbreak.

In spring, the highest *average grid cell density* of Tufted Puffins (6.50 birds/km^2) was located about 195 km west of Moresby Island. The largest group (30 birds) was seen on 15 June 1996, near Triangle Island. Overall, spring *average grid cell densities* ranged between 0.03-6.5 birds/km^2. The majority of the Tufted Puffin encounters were centred on the Scott Islands and Solander Island. Birds were found offshore as well, to approximately 930 km from land.

It appears that in summer Tufted Puffins were distributed closer to land; there were far fewer birds seen offshore. The largest summer aggregation (34 birds) we observed was about 30 km southwest of Triangle Island on 26 June 1994. As during spring, the highest *average grid cell densities* were near the Scott Islands and Solander Island; as well as west of Forrester Island. During summer, Tufted Puffins were again found offshore, to approximately 915 km from land.

Tufted Puffins were infrequently encountered during fall; only 22 birds were observed overall (*average grid cell density* ranged between 0.3 and 3.3 birds/km^2). The majority of birds were found between approximately 430 and 760 km from land. The exceptions were sightings at the shelfbreak west of Clayoquot Sound and west of Anthony Island, and an observation over slope waters approximately 100 km west of Iphigenia Bay.

During winter surveys, Tufted Puffins were routinely found in offshore regions (out to >1000 km from land), consistent with reports of their highly pelagic nature (Piatt and Kitaysky 2002b). The majority of birds were south of 50° N and none were found over the shelf. Morgan *et al.* (1991) had no records of Tufted Puffins during winter; this likely had more to do with an absence of winter offshore surveys than with an absence of puffins at that time of year.

The Tufted Puffin is considered to be an uncommon to fairly common summer visitor, becoming very abundant near the breeding colonies; rare to locally uncommon summer visitor to the northern mainland coast, the Strait of Georgia and Juan de Fuca Strait; and casual in winter along the southern coast of Vancouver Island. Tufted Puffins have been observed in all months, but mostly between May and August (Campbell *et al.* 1990b).

3.1.10 Rare, Unconfirmed and Hypothetical Species

The species presented below include those that have been encountered in the study area only a few times before, as well as species that have not been reported before and as such should be considered at this time as unconfirmed or hypothetical. Because all of these sightings were made by single observers, we cannot discount the possibility that the birds were incorrectly identified. That said however, we are including them here in case the species are encountered in the study area in the future.

Manx Shearwater (*Puffinus puffinus*).
© Ben Lascelles, BirdLife International.

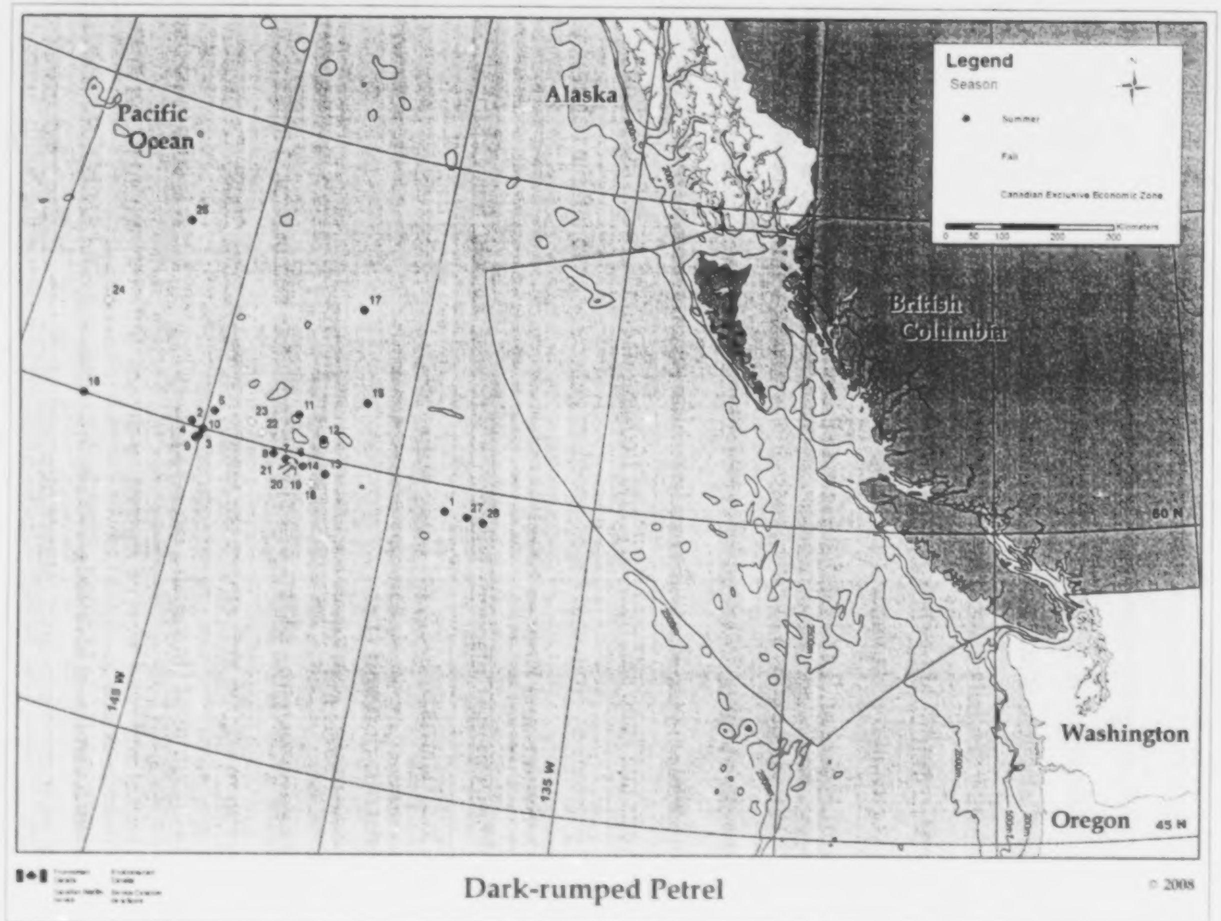

Figure 51. Locations where Dark-rumped Petrels have been observed.

See Appendix 1 for details.

3.1.10.1 Dark-rumped Petrel *Pterodroma sandwichensis* or *P. phaeopygia*

3.1.10.1.1 Population and Conservation Status

The 'Dark-rumped' Petrel has been split into two separate species: the Hawaiian Petrel (*P. sandwichensis*) and the Galapagos Petrel (*P. phaeophygia*). The Hawaiian Petrel is globally listed by the IUCN as *Vulnerable* with population size estimates from 19,000 (BirdLife International 2008) to 34,000 birds (Simons and Hodges 1998). NatureServe (2008) lists the Hawaiian Petrel as *Imperilled* and the Galapagos Petrel as *Critically Imperilled*. The IUCN ranks the global status of the Galapagos Petrel as *Critically Endangered* with a population of only 10,000-30,000 individuals (BirdLife International 2008).

3.1.10.1.2 Breeding Distribution and Chronology

The Hawaiian Petrel breeds in the Hawaiian Islands on Kauai, Maui, Lanai and Hawaii and possibly on Oahu. Most Hawaiian Petrel adults return to the breeding colonies in late February/early March, for the next two to three weeks, clean and/or enlarge their burrows. In late March, a pre-laying absence begins, followed by egg-laying between late April and mid-May. The pair divides the incubation period into four or five shifts (average length 16-17 days), hatching occurs between late June and mid-July, and fledging occurs between the second week of October and early November. Non- and failed-breeders generally have left the colony by mid-August (Simons 1985, Simons and Hodges 1998).

The Galapagos Petrel nests in the Galapagos Islands, on Floreana, Isabela, San Cristobal, San Salvidor, and Santa Cruz (Harrison 1983, del Hoyo *et al.* 1992).

3.1.10.1.3 Oceanic Distribution and Diet

Hawaiian and Galapagos Petrels may range thousands of kilometres from their nesting colonies, even during breeding season; satellite tracking of Hawaiian Petrels demonstrated that breeding birds embark on long (up to 10,000 km) clockwise foraging trips (Adams 2007). During the non-breeding season the distribution of Hawaiian Petrels is poorly known, but it is suspected that they disperse north to the boreal zone and west of Hawaii, with very little movement to the south or east (del Hoyo *et al.* 1992, Ainley et al. 1997).

Galapagos Petrel in the non-breeding season disperses eastwards towards the South American littoral, extending to seas west of MX and Panama and south to the Gulf of Guayaquil, Northern Peru and the Humboldt Current (Harrison 1983, del Hoyo *et al.* 1992, Ainley et al. 1997).

Like many other *Procellariidae*, Hawaiian and Galapagos Petrels forage by seizing prey at the surface and by scavenging. Regurgitated food loads brought back to the young consisted primarily of squid, with lesser amounts of fish (including flying fish and lantern fish), and crustaceans (isopods and shrimp) (Simons 1985, Simons and Hodges 1998).

3.1.10.1.4 Distribution in Study Area

It is virtually impossible to differentiate the two species at sea (Harrison 1983) and as such, we have recorded the sightings as 'Dark-rumped' Petrels. The satellite tracking of Hawaiian Petrel by Adams (2007) demonstrated that breeding birds that embark on long clockwise foraging trips cross through the area where we encountered most 'Dark-rumped' Petrels. Although this is not conclusive proof, it does suggest that the birds shown in Fig. 51 were Hawaiian Petrels. Between 1996 and 2007, 27 'Dark-rumped' Petrels were seen within the study area; most sightings (single birds only) occurred between 20 August and 20 September. The earliest sighting was 11 June (1999) and there were four encounters in the first half of July (2002 and 2007).

All observations of 'Dark-rumped' Petrels occurred between approximately 500 and 950 km from the nearest land; and >75% within 200km of Pathfinder Seamount.

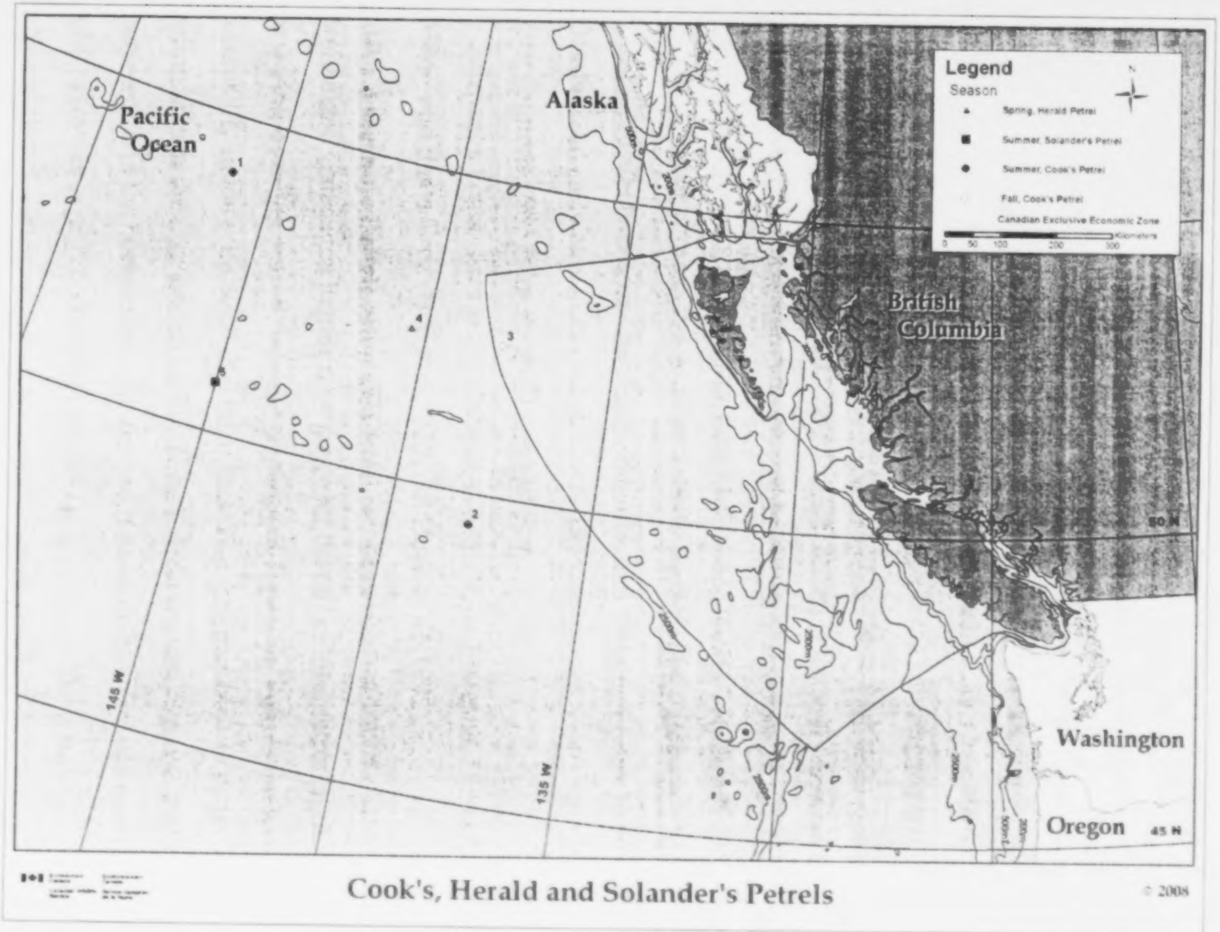

Figure 52. Locations where Cook's, Herald and Solander's Petrels have been observed. See Appendix 1 for details.

3.1.10.2 Cook's Petrel *Pterodroma cookii*

3.1.10.2.1 Population and Conservation Status

Cook's Petrel, listed by the IUCN as globally *Endangered*, has a total population estimated between 150,000 and 200,000 birds (BirdLife International 2008). NatureServe (2008) ranks the Cook's Petrel as *Imperilled* to *Vulnerable*. However, in marked contrast, Kushlan *et al*. (2002) consider the Cook's Petrel as *Not Currently at Risk* for N America.

3.1.10.2.2 Breeding Distribution and Chronology

Nesting occurs on only three islands in New Zealand: Codfish Island, Little Barrier Island and Great Barrier Island (Marchant and Higgins 1990, BirdLife International 2008). Their breeding season begins in October, eggs are laid between November and December, and colony dispersal takes place during March and April (Harrison 1983).

3.1.10.2.3 Oceanic Distribution and Diet

Most of the Cook's Petrels observed in the N Pacific have been found off Baja California, and to a lesser degree, off the southern coast of CA, especially seaward of the slope (Roberson and Bailey 1991). They are present there in all months, with abundance peaking in April-May and again in August (Bartle *et al.* 1993, Rintoul *et al.* unpubl. 2006). Some birds disperse westward and northwards in June to the temperate and sub-Arctic central Pacific; and are "….*seemingly localized within this huge region over areas of upwelling and along the Subarctic Boundary*" (Bartle *et al.* 1993). Cook's Petrels have been reported near the Hawaiian Islands as well as close to the Aleutian Islands (Harrison 1983, Pyle and Eilerts 1986, cited in Bartle *et al.* 1993). Wahl *et al.* (2005) reported that on 15 December 1995 a dead Cook's Petrel was beached south of Grays Harbor, WA; and two possible Cook's Petrels were seen on 1 August 2002 approximately 140 km west of the OR coast.

According to Marchant and Higgins (1990) most records of Cook's Petrels from the N Pacific are from areas where the sea-surface temperatures were between 15 and 25°C; they have rarely been found over colder waters. It has also been suggested that their occurrence and abundance off the west coast of N America is influenced by El Niño conditions (Marchant and Higgins 1990).

Cook's Petrels feed primarily on squid, fish, crustaceans and bioluminescent tunicates that are likely hunted at night (Imber 1996), and mostly obtained by surface-seizing (Marchant and Higgins 1990).

3.1.10.2.4 Distribution in Study Area

One Cook's Petrel was observed in the study area on 17 July 1993, approximately 850 km west of Langara Island; another was encountered on 18 June 1999 (about 820 km west of Vancouver Island); and a third was sighted on 6 October 2002 (roughly 445 km west of Anthony Island). Although well outside the study area, a fourth Cook's Petrel was seen on 15 February 2002 approximately 1,930 km west of the Olympic Peninsula. In what must be one of the most unusual sightings in recent years, on 4 December 2007, a live but weakened Cook's Petrel was found in Lillooet, BC. Lillooet is approximately 145 km from the nearest marine waters (Howe Sound). The discovery of this bird followed in the wake of several days of extreme storms that had tracked northeast across the Pacific Ocean. Apparently Cook's Petrels regularly over-fly land in New Zealand, where they once nested at least 100 km inland (J.A. [Sandy] Bartle, pers. comm.).

3.1.10.3 Herald Petrel *Pterodroma heraldica*

3.1.10.3.1 Population and Conservation Status

The Herald Petrel has recently been separated from *P. arminjoniana*, of the Indian Ocean (Brooke and Rowe 1996, Garnett and Crowley 2000), which is now referred to as the Round Island Petrel (Garnett & Crowley 2000). These two species were formerly considered to be a single species, with an extensive subtropical breeding range across the Pacific, Indian and Atlantic Oceans (Blakers *et al.* 1984, Marchant and Higgins 1990).

Despite there being relatively little known about this species, and a worldwide population estimated at only 150,000 birds (Brooke 2004), the Herald Petrel is considered by the IUCN to be a species of *Least Concern* globally (BirdLife International 2008). NatureServe (2008) ranks the species globally as *Apparently Secure*. However, in contrast, the species is listed as *Critically Endangered* in Australia under the *Environment Protection and Biodiversity Conservation Act 1999* (Australian Department of the Environment and Heritage 2005); and as a N. American species of *High Conservation Concern* (Kushlan *et al.* 2002).

3.1.10.3.2 Breeding Distribution and Chronology

The Herald Petrel breeds on Raine Island and possibly other small cays in the Coral Sea, (Garnett and Crowley 2000). It also breeds on a number of other islands in the S Pacific and Indian Oceans including Easter Island, French Polynesia, the Cook Islands, the Pitcairn group; and the Tonga group (Harrison 1983). Birds attend the colonies throughout the year, with the

possibility that some birds nest during the austral summer; most however, breed between March and September (Bailey *et al.* 1989, King and Reimer 1991, Imber *et al.* 1995).

3.1.10.3.3 Oceanic Distribution and Diet

Gould (1983) observed Herald Petrels as far north as almost 39° N, between AK and HI in 1976; however, sightings of this species north of the equator are considered quite rare.

Herald Petrels feed on squid, fish, crustaceans and insects (Imber *et al.* 1995) which are caught by dipping, surface-plunging and aerial-pursuit (Spear and Ainley 1998).

3.1.10.3.4 Distribution in Study Area

We observed a single Herald Petrel in the study area at approximately 52.40° N, 140.39° W (roughly 515 km west of Graham Island) on 4 April 2004.

3.1.10.4 Solander's Petrel *Pterodroma solandri*

3.1.10.4.1 Population and Conservation Status

Also known as Providence Petrel, this species is ranked globally as *Vulnerable* by the IUCN (BirdLife International 2008). The entire population is estimated at only 64,000 individuals (BirdLife International 2008).

3.1.10.4.2 Breeding Distribution and Chronology

The entire breeding population is limited to two islands (Lord Howe Island and Phillip Island) in the southwest S Pacific (Marchant and Higgins 1990). The breeding season of Solander's Petrel is from mid-February to November; breeders return to the colonies in mid-February, eggs are laid in mid-late May, hatching begins in mid-July and most chicks have departed by November (Marchant and Higgins 1990).

3.1.10.4.3 Oceanic Distribution and Diet

Although little information exists on pelagic dispersal, most at-sea sightings of Solander's Petrel are from Australian waters; however, they have been reported from waters off HI (Harrison 1983) and Japan (Tanaka 1986) and the GOA. During the non-breeding season, the species has been observed over waters with a wide range of surface temperatures (3.5 – 28°C). They apparently concentrate along convergences of cold and warm currents; with some immatures and non-breeders occurring near the Sub-Arctic Front during the breeding season.

Solander's Petrels feed on squid, fish, crustaceans and offal (Marchant and Higgins 1990, BirdLife International 2008).

3.1.10.4.4 Distribution in Study Area

A single Solander's Petrel was observed within the study area; it was seen on 17 June 1997, approximately 85 km north of OSP.

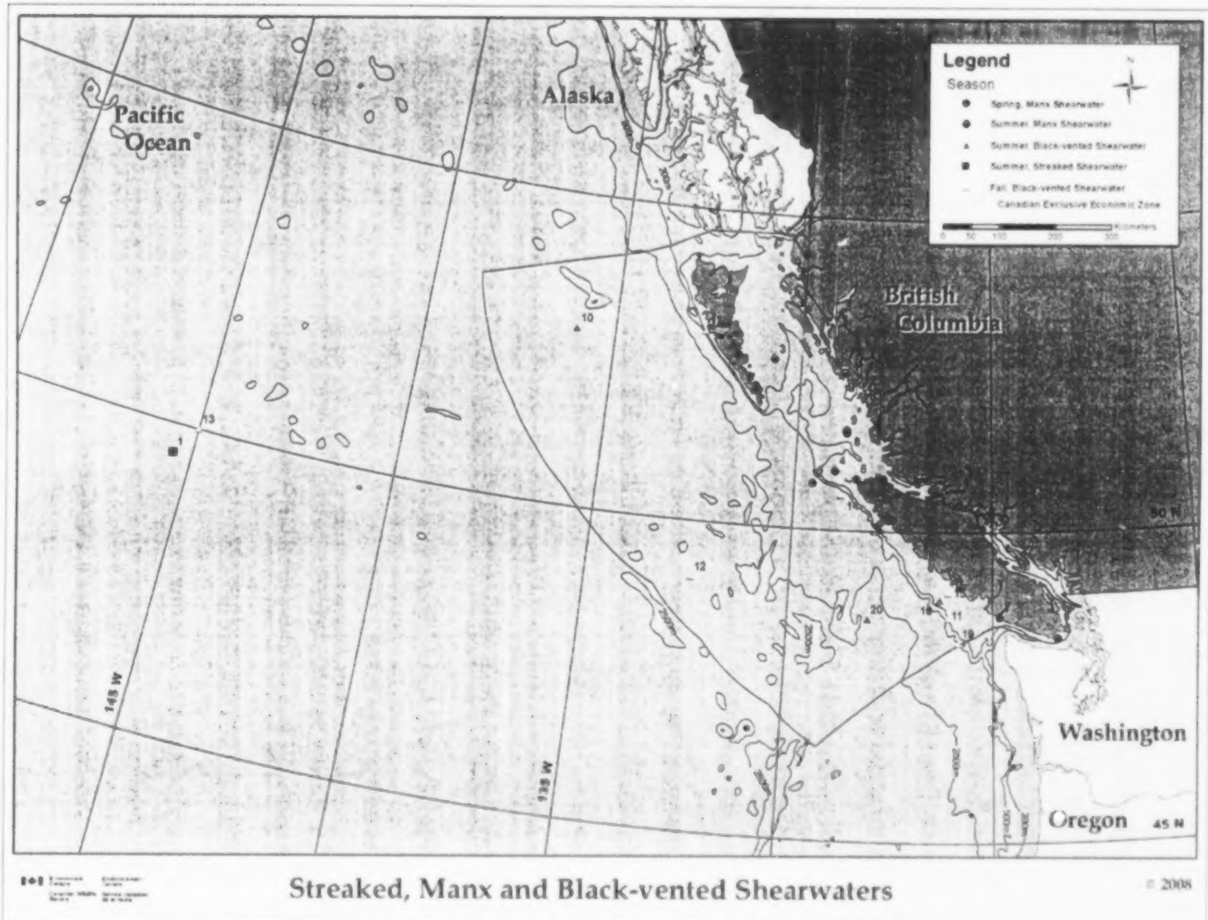

Figure 53. Locations where Streaked, Manx and Black-vented Shearwaters have been observed. See Appendix 1 for details.

3.1.10.5 Streaked Shearwater *Calonectris leucomelas*

3.1.10.5.1 Population and Conservation Status

With a global population estimated between 3 and 5 million individuals (Everett and Pitman 1993, Brooke 2004) the Streaked Shearwater is considered by the IUCN to be a species of *Least Concern* globally (BirdLife International 2008).

3.1.10.5.2 Breeding Distribution and Chronology

Streaked Shearwaters nest in the far-western N Pacific through the Izu, Ryuku, Daito and Senkaku groups to islands off Hokkaido, Japan; they also breed on islands off Korea and south-east Russia (Onley and Scofield 2002, Brooke 2004, Marchant and Higgins 1990).

The nesting season lasts from March to November with egg-laying beginning in May and peaking in mid- to late June. Incubation generally lasts about 55 days, and the majority of eggs hatch around the middle of August. The fledging period ranges between 66 and 80 days, and adults and fledglings depart the colonies from October to December (Everett and Pitman 1993, Brooke 2004).

3.1.10.5.3 Oceanic Distribution and Diet

After the breeding season, the population migrates to the south-east China Sea, waters off the Philippines, Indonesia and New Guinea; the Coral Sea and the Indian Ocean as far as Sri Lanka, the Maldives and the Abrolhos Islands off Western Australia (Harrison 1983, Onley and Scofield 2002, Brooke 2004, Marchant and Higgins 1990). Vagrants have also been reported from the coasts of South Africa, CA and OR (Force *et al.* 1999, Marchant and Higgins 1990).

3.1.10.5.4 Distribution in Study Area

On 6 July 2002, a single Streaked Shearwater was seen by an observer who is very familiar with the species, approximately 55 km southwest of OSP. Other sightings from the west coast of N America have occurred between approximately mid-August and mid-October (Roberson 1980, Force *et al.* 1999).

Streaked Shearwaters feed on fish and squid which are caught by surface-seizing or by shallow plunges, not completely submerging (Kuroda 1954, Brooke 2004, Marchant and Higgins 1990).

3.1.10.6 Manx Shearwater *Puffinus puffinus*

3.1.10.6.1 Population and Conservation Status

The Manx Shearwater is the nominate member of at least eight forms, many or all often regarded as separate species; distinguishing between these forms at sea can be very difficult. The Manx

Shearwater is classified by the IUCN as a species of *Least Concern* (BirdLife International 2008), of *Moderate Conservation Concern* in N America (Kushlan *et al*. (2002) and *High Concern* in Canada (Milko *et al.* (2003). The global population is estimated at 600,000 individuals (BirdLife International 2008).

3.1.10.6.2 Breeding Distribution and Chronology

Most Manx Shearwaters breed in the United Kingdom and Ireland, where the breeding population is estimated at 280,000 to 310,000 pairs. Smaller colonies also occur on Iceland and the Faeroe Islands, as well as in France, the Madeira Archipelago and the Azores (Mlodinow 2004). There is only one known active Manx Shearwater colony in N America; approximately 150 pairs nest on Middle Lawn Island, NL (Robertson 2002). The global population of this species is estimated to be between 340,000 and 410,000 pairs (Mlodinow 2004). Manx Shearwaters are at their colonies from mid-April to the end of October.

3.1.10.6.3 Oceanic Distribution and Diet

Non-breeding adults and immatures leave their natal areas in July or August, and adults and fledglings depart the colonies in August or September; the last birds are usually seen in October (Lee and Haney 1996). Following dispersal, Manx Shearwaters migrate across the equator to spend the austral summer off the southeast coast of South America as well as off South Africa (Harrison 1983, Lee and Haney 1996).

Sightings of Manx Shearwaters from the west coast of N America have long been thought to either be 'disoriented' birds that migrated north from the Cape Horn area, into the 'wrong' ocean, or that they were actually Newell's Shearwater (*P. auricularis newelli*) dispersing northeast from HI (Harrison 1983, Lee and Haney 1996). However, it is unlikely that the northeast N Pacific sightings have been of Newell's Shearwaters as it is a tropical breeder that is closely associated with warm tropical and sub-tropical sea surface temperatures (Force *et al.* 2006). There has been a dramatic increase in the number of Manx Shearwaters in the northeast N Pacific over the past two to three decades Force (*et al.* 2006), raising the possibility that the species might either be nesting or prospecting somewhere in the area (Jaramillo 2003, Mlodinow 2004).

Although there have been numerous reports of 'Manx-type' shearwaters from the GOA and the southern Bering Sea, for more than 30 years, Manx Shearwaters were only added to the AK species list in 2008. Two birds were seen together near Middleton Island, AK (approximately

59.43° N, 146.33°) W on 12 May 2005 and again in the same area from 3 – 24 July 2005 (Gibson *et al.* 2008). The authors suggested that they were: "*…perhaps a pair prospecting for a possible nest site*". Wahl *et al.* (2005) reported that small numbers of Manx Shearwaters were recorded annually off WA in the late 1990's; birds were encountered there from 24 March through 10 October, with most sightings in June and July.

Manx Shearwaters feed primarily on fish (e.g., herring, sardines), and to a lesser extent on squid; prey are captured either by surface-seizing or by underwater pursuit (Brooke 2004, Cramp and Simmons 1977).

3.1.10.6.4 Distribution in Study Area

Including data from other sources, there were eight sightings of Manx Shearwaters within the study area. There were also two other observations, but both were considerably west of the study area (Morgan 1993). Six of the encounters were located between the northern tip of Vancouver Island and the southern end of the QCI; two others were from Juan de Fuca Strait area. Manx Shearwater sightings within the study area occurred between 4 May and 8 August. The status of Manx Shearwaters in the northeastern N Pacific is unclear; however, what is cler is that this species is a rare but regular member of the Canadian west coast seabird avifauna (Force *et al.* 2006).

3.1.10.7 Black-vented Shearwater *Puffinus opisthomelas*

3.1.10.7.1 Population and Conservation Status

The current world population of Black-vented Shearwaters is estimated between 55,000 and 95,000 pairs. The Black-vented Shearwater is listed globally as *Near Threatened* (BirdLife International 2008) or as *Imperilled* (NatureServe 2008), and as a species of *High Conservation Concern* in N America (Kushlan *et al.* 2002). As it is considered to be accidental in Canada (BCCDC 2006), it has no national or provincial listings.

3.1.10.7.2 Breeding Distribution and Chronology

The majority (>95%) of Black-vented Shearwaters breed on Natividad Island, Baja California Sur, MX (Keitt *et al.* 2000a). Egg-laying occurs between January and early April (Keitt 1998, Del Hoyo *et al.* 1992) and post-breeding dispersal occurs between June and August (Keitt *et al.* 2000a).

3.1.10.7.3 Oceanic Distribution and Diet

Although many Black-vented Shearwaters remain near the breeding areas year-round (Keitt *et al.* 2000a); they range along the Pacific coast of N America, mainly from central CA south to Baja California and the northwest mainland of MX. In contrast to many other *Procellariidae*, Black-vented Shearwaters are most frequently found in coastal waters, often within 25 km of shore (Briggs *et al.* 1987, Keitt *et al.* 2000a). Rintoul *et al.* (unpubl. 2006) reported that the highest densities of Black-vented Shearwaters in CA were from shelf waters during fall and winter. Black-vented Shearwaters eat small fish (mainly northern anchovies and Pacific sardines), as well as squid and crustaceans. They forage in a variety of ways including plunging from just above the surface, plucking food from the surface, or diving while paddling along the surface (Keitt *et al.* 2000a). Black-vented Shearwaters routinely dive to depths exceeding 20 m, with an overall recorded maximum depth of 52 m (Keitt *et al.* 2000b).

3.1.10.7.4 Distribution in Study Area

We report a total of 11 records from the study area; these sightings combine old Black-vented Shearwater records (from Guzman and Myres 1983 and Morgan *et al.* 1991) with a single 'recent' observation (from 23 June 1999). Other than the Guzman and Myres sighting, these observations are in addition to the nine records (11 birds including five specimens collected) that Campbell *et al.* (1990a) present, but do not give detailed locations. Most of the birds were observed over the shelf or along the shelfbreak west of Vancouver Island; there were also two offshore reports of Black-vented Shearwaters. All of the reports were between June and October; and with one exception, all were pre-1990. Campbell *et al.* (1990a) reported that Black-vented Shearwaters had occurred in BC between early July and early November, as well as a single observation in February.

Force *et al.* (2006) suggest that any questionable records of black and white shearwaters seen in the province should be re-examined. Spring records especially should be considered suspect and "*...could very well have been Manx Shearwaters*". Although the timing of most of the sightings listed in Appendix 1 fall within the window of accepted Black-vented Shearwaters (i.e., July to November, Campbell *et al.* 1990a), it is conceivable that observers pre-1989 were biased by the assumption that an Atlantic shearwater species 'could not occur' off the BC coast and that the only 'expected' small black and white shearwater would be the Black-vented Shearwater (Force

et al. 2006). Therefore, we suggest that it is possible that an unknown number of Black-vented Shearwater sightings presented in Appendix 1 might actually have been Manx Shearwaters. Campbell *et al.* (1990a) suggested that records of Black-vented Shearwaters from BC waters may be due to warm water events.

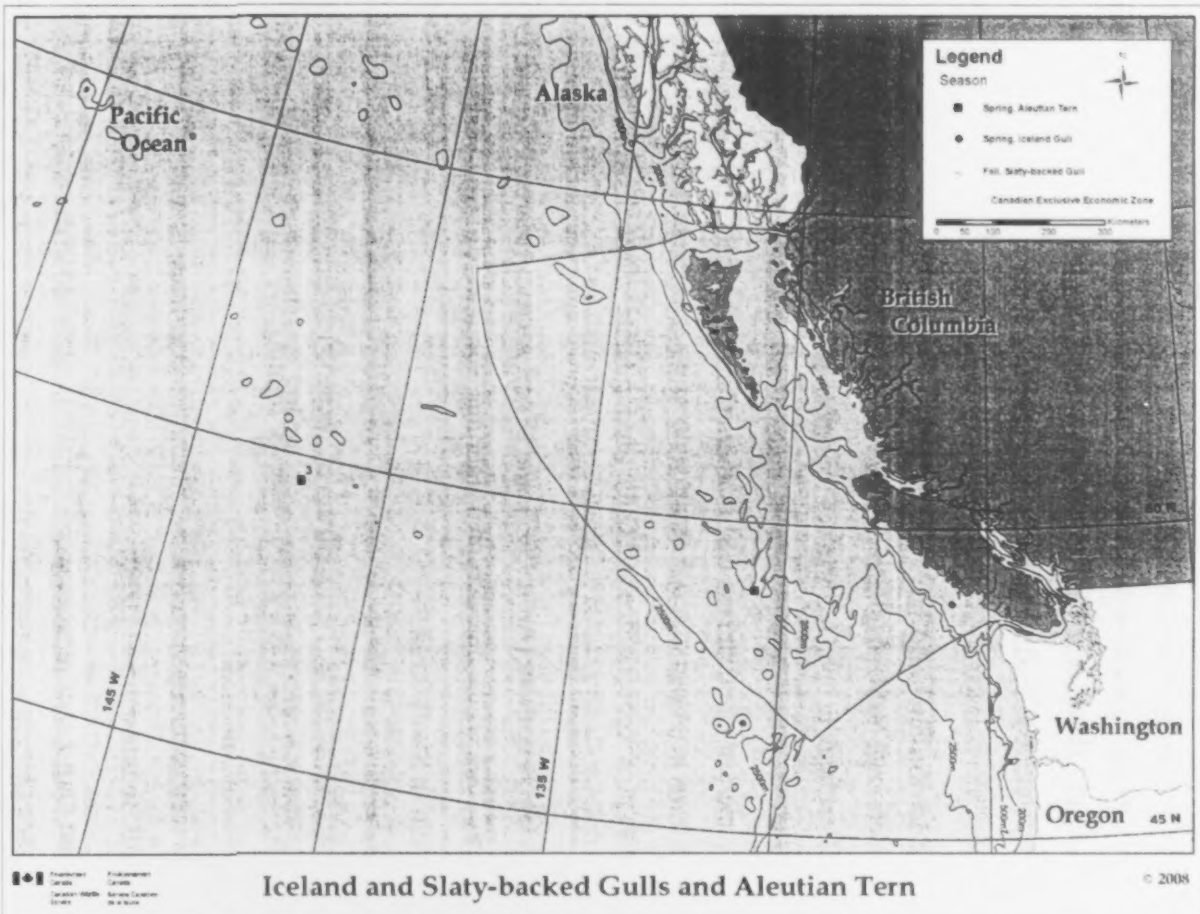

Figure 54. Locations where Iceland and Slaty-backed Gulls and Aleutian Terns have been observed. See Appendix 1 for details.

3.1.10.8 Iceland Gull *Larus glaucoides*

3.1.10.8.1 Population and Conservation Status

Considered globally as a species of *Least Concern* by the IUCN, the Iceland Gull has a large population of >400,000 birds (BirdLife International 2008).

3.1.10.8.2 Breeding Distribution and Chronology

Iceland Gulls breed in N America's eastern Arctic and Greenland. According to Snell (2002) there is little overlap between the breeding distributions of the Iceland Gull and the Thayer's Gulls. Iceland Gulls are at their breeding grounds from May to August with migrations occurring in April and September-October (Snell 2002).

3.1.10.8.3 Oceanic Distribution and Diet

The majority of the nominate taxon (*L. glaucoides glaucoides*) winter in the Arctic along the southwest coast of Greenland, in open leads in sea ice and in polynyas; they are also found in polynyas in north-eastern N America, the United Kingdom, and Scandinavia. Winter records of nominate *glaucoides* and *kumlieni* from the US, southern Canada, Iceland, Faeroes, and Europe are mostly immature birds in coastal regions. (Snell 2002, Roberson 2004).

Wahl *et al.* (2005) lists nine records of Iceland Gulls (during January, March, April, November and December) that have been accepted by the WA bird record committee; including sightings of first-year birds sw of Grays Harbour (April 1997), and at Port Angeles (March 1986 and 1989), and Tacoma (January 2000). Of the nine accepted sightings, seven were of first-year birds

3.1.10.8.4 Distribution in Study Area

A probable first-year Iceland Gull was observed on 27 May 1989, southwest of Barkley Sound over La Perouse Bank (Morgan *et al.* 1991). However, because Iceland Gulls are hard to identify, especially at sea, and this was a single-observer sighting, we caution that this record should be considered as hypothetical.

At sea, Iceland Gulls feed primarily upon fish and marine invertebrates, as well as carrion and fishery discards (BirdLife International 2008).

3.1.10.9 Slaty-backed Gull *Larus schistisagus*

3.1.10.9.1 Population and Conservation Status

The total world breeding population of Slaty-backed Gulls is estimated at 131,300 pairs, with more than 120,000 pairs nesting in Russia. It is considered globally to be of *Least Concern* by

the IUCN (BirdLife International 2008). The Slaty-backed Gull is primarily an Asian species but it is also a rare but regular visitor to the west coast of N America.

3.1.10.9.2 Breeding Distribution and Chronology

Slaty-backed Gulls breed in the Russian Far East along most of the mainland coast, from western Kamchatka to the China border. Nesting continues south through the Kuril Islands and the Sea of Okhotsk, to Hokkaido and northern Honshu, Japan (Denlinger 2006, Shimba 2007). In 1996 the first confirmed breeding record of Slaty-backed Gulls in AK was from Aniktun Island; a small barrier island south-southwest of Cape Romanzoff (McCaffery *et al.* 1997, Denlinger 2006). Adults return to the colonies in late April to early May, eggs are laid in May/early June and fledging and dispersal takes place in August and September (Harrison 1983).

3.1.10.9.3 Oceanic Distribution and Diet

Slaty-backed Gulls winter from the Kuril Islands to southern Japan (Harrison 1983). It is a rare spring migrant and summer and fall visitor along the Bering and Chukchi seas (Denlinger 2006). They are also a very rare winter visitor to western WA; there are five records (all adults) between December and April (Wahl *et al.* 2005).

Fish (e.g., capelin, Pacific herring, Pacific sandlance), marine invertebrates, offal and carrion are consumed by Slaty-backed Gulls, and during the breeding season, they also feed on the chicks of other seabird species, small mammals, berries and garbage (Watanuki 1989, Zelenskaya and Khoreva 2006)

3.1.10.9.4 Distribution in Study Area

At the beginning of the 1990's, the only two BC records of Slaty-backed Gulls were from Vancouver Island (Campbell *et al.* 1990b). However, since 1993, this species has been recorded annually near Vancouver BC, and in southeast AK. On 20 October 1986, an adult Slaty-backed Gull was observed over the eastern edge of Swiftsure Bank (Morgan *et al.* 1991).

3.1.10.10 Aleutian Tern *Sterna aleutica*

3.1.10.10.1 Population and Conservation Status

The Aleutian Tern has a global population estimated at 35,000 individuals and is listed by the IUCN as a species of *Least Concern* (BirdLife International 2008).

3.1.10.10.2 Breeding Distribution and Chronology

Aleutian Terns breeding only in eastern Siberia and AK; nesting along the coasts of the Bering, Okhotsk and southern Chukchi Seas. Birds return to their AK colonies in early May, and dispersal takes place in August or September (Harrison 1983, North 1997).

3.1.10.10.3 Oceanic Distribution and Diet

Commenting on the at-sea distribution of this species, Harrison (1983) stated "*Its wintering range remains a mystery.*"

Aleutian Terns feed on fish (e.g., capelin, Pacific sandlance) and euphausiids (e.g., *Thysanoessa inermis*) at sea and insects during the breeding season. At-sea foraging usually occurs at the water surface or by shallow plunge dives (North 1997).

3.1.10.10.4 Distribution in Study Area

Campbell *et al.* (1990b) consider the Aleutian Tern to be a casual visitor to the QCI; there are four records - two from the Masset area (May 1983 and 1985) and two from the southwest tip of the QCI (June 1987 and May 1989).

Two Aleutian Terns were seen during this study; one on 23 May 1996, approximately 215 km east, southeast of OSP, and the other on 7 June 1997, roughly 205 km west, southwest of Brooks Peninsula.

4. SUMMARY

Approximately 25% of the species covered by this atlas occurred predominantly, to exclusively, in the offshore regions of the study area. The species in the offshore group were: Laysan Albatross, Mottled, Murphy's, Dark-rumped, Cook's, Herald and Solander's petrels, Streaked Shearwater, Leach's Storm-Petrel, Long-tailed Jaeger, and Horned and Tufted puffins. Due to the rarity of several of these species, the reader is cautioned against assuming that they never occur over the continental shelf/slope region. More than 35% of the species we documented were associated predominantly with the shelf/slope region; this group included: Flesh-footed, Pink-footed, Manx and Black-vented shearwater, Pomarine Jaeger, Bonaparte's, Mew, California, Thayer's, Iceland, Slaty-backed, Western and Glaucous gulls, Common Murre, Pigeon Guillemot, Marbled and Ancient murrelets, and Rhinoceros Auklet. The remaining species were found over the shelf/slope and the offshore regions. Species in this group included: Black-footed and Short-tailed albatrosses, Northern Fulmar, Buller's, Sooty and Short-tailed shearwaters,

Fork-tailed Storm-Petrel, Red/Red-necked Phalaropes, South Polar Skua, Parasitic Jaeger, Herring, Glaucous-winged and Sabine's gulls, Black-legged Kittiwake, Arctic and Aleutian terns, Thick-billed Murre, Xantus's Murrelet, and Cassin's and Parakeet auklets.

Variability in the distribution and abundance of seabirds is influenced by many factors, including time of year, nesting location, breeding status, availability and abundance of their preferred prey, migratory routes, etc. The breeding cycle of a species influences its oceanic distribution, on many scales. Some species migrate through the study area en route to or from their nesting grounds (e.g., jaegers, Arctic Tern, phalaropes); some spend their non-breeding seasons in the N Pacific (e.g., Mottled Petrel, Sooty Shearwater); and others breed within the study area and are year-round residents (e.g., Glaucous-winged Gull, Cassin's Auklet).

Although with few exceptions, the data included in the atlas cover the periods 1982 to 1984 and 1990 through 2005; the vast majority were collected since 1995. The pre-1995 data were included to make this atlas as complete as possible.

At the onset of developing the atlas we made the assumption that over the past two decades, the N Pacific environment had not changed so dramatically to have caused a complete re-distribution or restructuring of the seabird community. Because of that decision, we used the entire data set to derive the various seabird metrics (e.g., average grid cell density).

Anderson and Piatt (1999), Hare and Mantua 2000 and others, have demonstrated that marine invertebrate and fish communities respond to climate change and regime shifts in a variety of ways including radical alterations in the community structure, levels of abundance and/or their spatio-temporal distribution. Many of those organisms are important prey of seabirds; consequently, it is to be expected that the seabird community would be impacted by those lower trophic level changes.

Summarizing the work of others, Irons *et al.* (2008) stated that in addition to the general global pattern of rising temperatures, which in turn are superimposed on a N Pacific warming trend, are "*cyclical patterns created by decadal oscillations*". Those N Pacific oscillations are associated with periodic shifts in wind patterns that affect ocean mixing and sea-surface temperature. Examining the fluctuations of Thick-billed and Common Murre populations across the entire Arctic and sub-Arctic regions, Irons *et al.* (2008) found that the population of Thick-billed Murres increased most rapidly when sea-surface temperatures warmed slightly; while, the population of Common Murres underwent the most rapid growth during moderate cooling. The

authors attributed the changes in the murre populations to changes in the prey availability, rather than directly to changes in temperature.

If similar responses occur in other seabirds species, and we have no reason to suggest that they don't, it is quite likely that the 'world' that the seabirds were exploiting while we conducted this study, was undergoing considerable change. Consequently, our initial assumption that the N Pacific avifauna has not undergone a major re-distribution or restructuring may in fact have been wrong, and that the spatio-temporal patterns described here may actually represent a somewhat 'blurred snapshot' of a changing seabird community.

Despite the probability that seabird community is adjusting to climatic/oceanographic change, we consider that the basic distribution patterns presented here serve as an important tool for example during emergency response, or in regional marine and coastal zone planning, or in developing of more sustainable fisheries practices. In addition, in the coming decade there will likely be new threats to seabirds off Canada's west coast (e.g., marine wind farms or offshore oil and gas development); hopefully, the atlas will provide a mechanism for assessing the risks to and/or the impacts of these activities.

We encourage marine-resource managers to include this atlas as a tool in marine planning initiatives. Such use of the atlas will allow managers to make informed decisions regarding resource exploitation, shipping routes, and other activities that may be proposed.

The majority of the vessels that we have relied upon to gather the at-sea data have all been tasked with oceanographic studies, often along the same route (e.g., Line P). Although repeated survey transects allow for intra- and inter-annual comparisons, the end result is that there are still large gaps in where seabirds have been monitored in Canada's west coast EEZ. While some regions have been surveyed multiple times throughout the seasons; many other areas, notably those that are considered to be biologically important (e.g., Bowie Seamount) have received almost no monitoring attention. In addition to the spatial gaps, there still remain significant blocks of time lacking in observational data; this is clearly demonstrated by the paucity of data from the fall season, and by the complete absence of data from December.

It is likely impossible to predict with any degree of confidence, how the seabird community will change over the next few decades. Because of that uncertainty, coupled with the recognition that there are still many gaps to be filled, we hope that there will be continued support for monitoring of the at-sea distribution of seabirds along Canada's west coast. Without that continued

commitment to support the monitoring of the offshore bird community, it will become increasingly more difficult to conserve the rich and diverse seabird assemblage found along Canada's Pacific coast.

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6. APPENDIX 1

Sighting locations, dates, and numbers of individuals of rare species. Latitude and longitude are listed in decimal degrees and rounded to two decimal places.

Species	No. on Figure	Date (dd/mm/yyyy)	Latitude (° N)	Longitude (° W)	No. Observed (age[1])	Source[2]
Short-tailed Albatross (fig. 13)	1	11/06/1960	50.50	129.00	1 (I)	A
	2	03/05/1970	46.60	124.00	1 (S)	A
	3	24/06/1971	50.00	145.00	1 (I)	A
	4	26/06/1971	50.00	145.00	1 (I)	A
	5	08/10/1983	53.00	140.00	1 (n)	A
	6	13/10/1983	54.00	142.00	1 (n)	A
	7	14/10/1983	55.00	145.00	2 (n)	A
	8	15/10/1983	55.00	145.00	1 (n)	A
	9	30/07/1991	47.84	133.64	1 (I)	B
	10	21/09/1991	55.35	134.73	1 (J)	A
	11	02/09/1995	56.60	135.83	1 (n)	A
	12	23/02/1996	48.68	126.68	1 (I)	C
	13	22/10/1996	53.89	133.53	1 (S)	D
	14	01/07/1996	56.07	135.10	2 (n)	A
	15	15/05/1997	53.13	142.00	1 (J)	A
	16	11/09/1997	56.88	136.05	1 (I)	A
	17	17/11/1997	53.00	134.00	1 (n)	A
	18	24/03/1998	53.00	134.00	1 (I)	A
	19	27/04/1998	56.85	136.07	1 (I)	A
	20	07/05/1998	56.07	135.50	1 (J)	A
	21	16/06/1998	57.79	136.89	1 (I)	A
	22	10/08/1998	54.98	134.30	1 (J)	A
	23	23/08/1998	56.13	135.07	1 (J)	D
	24	17/01/1999	54.15	133.68	1 (I)	D
	25	19/01/1999	54.15	133.62	1 (J)	D
	26	12/04/1999	56.15	135.50	1 (I)	A
	27	08/05/1999	50.76	129.34	1 (A)	B
	28	12/05/1999	56.10	135.56	1 (I)	A
	29	09/06/1999	57.77	136.71	1 (n)	A
	30	17/06/1999	55.01	134.27	1 (I)	D
	31	25/07/1999	52.17	130.32	1 (J)	D
	32	02/07/2000	50.74	129.41	1 (I)	B
	33	27/08/2000	56.30	135.58	1 (I)	A
	34	08/09/2000	49.04	131.67	1 (I)	B
	35	25/09/2000	56.38	135.65	1 (I)	A
	36	30/10/2000	53.25	132.93	1 (I)	A
	37	30/10/2000	51.84	130.60	1 (I)	A
	38	10/11/2000	51.56	129.71	3 (A)	A
	39	11/11/2000	51.57	129.69	1 (A)	A
	40	09/07/2001	46.83	130.83	1 (I)	A
	41	21/08/2001	52.39	130.78	1 (I)	A
	42	25/08/2001	51.93	131.02	1 (I)	A
	43	02/09/2001	52.35	130.75	1 (I)	D

Species	No. on Figure	Date (dd/mm/yyyy)	Latitude (° N)	Longitude (° W)	No. Observed (age[1])	Source[2]
	44	10/10/2001	56.00	134.61	1 (I)	D
	45	14/10/2001	53.98	133.67	1 (A)	A
	46	27/10/2001	51.87	130.63	1 (I)	A
	47	27/10/2001	51.85	130.57	1 (I)	A
	48	10/11/2001	51.87	130.63	1 (I)	A
	49	15/10/2002	49.50	127.25	1 (I)	C
	50	27/04/2003	51.19	129.59	1 (I)	A
	51	08/08/2003	48.30	126.07	1 (J)	C
	52	15/06/2003	49.20	127.15	1 (I)	D
	53	17/06/2003	49.98	127.65	1 (I)	D
	54	22/06/2003	51.85	130.60	1 (I)	A
	55	23/06/2003	46.93	124.95	1 (A)	A
	56	11/01/2004	51.85	130.64	1 (I)	D
	57	06/07/2004	54.68	133.50	1 (I)	A
	58	18/09/2005	54.22	136.80	1 (I)	E
	59	05/06/2007	49.50	142.29	1 (I)	B
	60	07/01/2008	48.99	126.55	1 (J)	F
Flesh-footed Shearwater (fig. 18)	1	04/05/1982	48.68	127.00	1	G
	2	13/05/1983	52.52	130.32	1	G
	3	13/05/1983	52.47	130.47	1	G
	4	19/05/1983	48.73	127.67	1	G
	5	10/06/1983	53.15	130.90	1	G
	6	19/08/1983	49.47	137.53	1	G
	7	06/10/1983	48.50	124.73	1	G
	8	18/07/1988	48.62	126.47	1	G
	9	19/07/1988	48.83	126.18	1	G
	10	19/07/1988	48.87	126.02	1	G
	11	09/08/1988	49.50	127.03	1	G
	12	18/08/1988	48.33	125.53	1	G
	13	31/05/1989	49.17	133.85	1	G
	14	19/08/1989	48.22	125.85	1	G
	15	23/08/1989	48.52	126.40	1	G
	16	19/06/1998	51.40	129.35	1	B
	17	19/06/1998	51.37	129.25	1	B
	18	11/05/2000	48.75	126.22	1	B
	19	05/07/2000	53.72	130.95	1	B
	20	06/10/2002	52.78	139.93	1	B
	21	11/09/2003	51.32	129.09	1	B
	22	04/10/2006	56.88	141.60	1	B
Glaucous Gull (fig. 36)	1	03/03/1982	49.03	125.88	1	G
	2	13/03/1982	52.08	129.32	1	G
	3	19/03/1983	49.76	141.71	1	B
	4	10/05/1983	53.93	131.58	1	G
	5	18/05/1983	51.25	129.32	1	G
	6	19/05/1983	48.60	126.00	1	G
	7	23/01/1984	53.02	132.67	1	G
	8	06/04/1984	54.48	132.05	1	G
	9	14/04/1984	54.30	131.92	1	G
	10	18/04/1984	54.53	132.07	1	G

Species	No. on Figure	Date (dd/mm/yyyy)	Latitude (° N)	Longitude (° W)	No. Observed (age[1])	Source[2]
	11	18/04/1984	53.97	133.52	1	G
	12	20/04/1984	53.73	133.23	1	G
	13	20/04/1984	54.02	133.45	1	G
	14	02/05/1984	49.05	131.88	1	G
	15	15/10/1984	54.37	133.00	1	G
	16	21/10 .984	54.23	131.38	1	G
	17	27/02/1997	48.58	125.68	1	B
	18	04/11/1997	54.39	130.59	1	B
	19	06/02/2002	48.56	125.30	1	B
	20	16/09/2005	52.53	130.77	1	B
Thick-billed Murre (fig. 41)	1	21/05/1982	53.00	131.28	1	G
	2	14/09/1983	50.92	128.33	1	G
	3	13/01/1984	52.60	129.45	1	G
	4	14/01/1984	53.23	130.85	1	G
	5	17/01/1984	53.32	130.33	1	G
	6	18/01/1984	52.45	130.48	1	G
	7	18/01/1984	52.55	130.08	1	G
	8	19/01/1984	53.93	131.05	1	G
	9	30/10/1984	53.97	130.87	1	G
	10	31/10/1984	48.75	126.02	1	G
	11	24/01/1995	48.90	125.64	1	B
	12	09/02/1999	48.59	125.75	1	B
	13	20/02/1999	49.03	138.37	1	B
	14	25/02/1999	48.59	125.73	1	B
	15	08/02/2002	49.13	132.77	1	B
	16	18/02/2002	46.42	136.98	1	B
	17	18/02/2002	46.38	136.44	1	B
	18	19/02/2002	46.08	132.25	1	B
	19	19/02/2002	46.10	132.70	1	B
	20	19/02/2002	46.19	132.42	1	B
	21	30/06/2002	48.69	127.04	1	B
	22	11/02/2003	46.92	142.49	1	B
	23	11/02/2003	47.06	142.66	1	B
	24	11/02/2003	47.36	143.01	1	B
	25	22/02/2005	47.00	134.25	1	B
	26	24/02/2005	47.01	126.92	1	B
	27	05/04/2005	53.89	130.95	1	B
	28	05/04/2005	53.93	130.97	2	B
	29	05/04/2005	53.94	130.98	5	B
	30	05/04/2005	53.97	130.98	3	B
	31	05/04/2005	54.10	131.02	2	B
	32	05/04/2005	53.98	130.99	1	B
	33	05/04/2005	54.02	131.00	1	B
	34	05/04/2005	54.08	131.01	1	B
	35	05/04/2005	54.09	131.02	3	B
	36	05/04/2005	54.12	131.03	12	B
	37	05/04/2005	54.17	131.04	12	B
	38	06/04/2005	55.36	136.85	1	B
	39	22/09/2005	53.16	130.62	1	B

Species	No. on Figure	Date (dd/mm/yyyy)	Latitude (° N)	Longitude (° W)	No. Observed (age[1])	Source[2]
Xantus's Murrelet (fig. 44)	1	25/10/1971	51.25	129.97	1	H
	2	08/09/1974	46.92	124.18	1	I
	3	08/09/1974	46.92	124.57	1	I
	4	08/09/1974	46.92	124.72	1	I
	5	11/10/1974	46.92	124.67	6	I
	6	24/08/1975	46.92	124.18	2	I
	7	24/08/1975	46.88	124.37	17	I
	8	24/08/1975	46.85	124.53	1	I
	9	18/07/1976	46.90	124.28	1	I
	10	20/08/1977	46.90	124.18	2	I
	11	20/08/1977	46.90	124.90	1	I
	12	09/10/1977	46.90	124.18	2	I
	13	10/09/1978	46.90	127.97	2	I
	14	10/09/1978	46.97	125.08	1	I
	15	11/09/1978	46.93	124.85	2	I
	16	11/09/1978	46.95	125.12	4	I
	17	01/08/1981	48.80	126.60	1	I
	18	08/10/1981	46.92	124.97	6	I
	19	08/10/1981	46.92	125.05	8	I
	20	08/10/1981	46.85	125.02	4	I
	21	28/07/1983	46.95	124.27	1	I
	22	28/07/1983	46.92	124.85	2	I
	23	11/09/1983	46.92	124.35	2	I
	24	15/08/1984	47.00	124.70	1	I
	25	09/09/1985	46.98	124.68	1	I
	26	12/09/1987	46.83	124.80	1	I
	27	04/10/1987	46.85	124.82	1	I
	28	26/08/1988	48.10	126.83	2	G
	29	31/10/1988	48.37	125.87	2	G
	30	20/06/1990	47.38	124.46	2	J
	31	21/06/1990	46.38	124.12	4	J
	32	29/06/1990	47.71	124.54	1	J
	33	29/06/1990	47.79	124.54	1	J
	34	29/06/1990	48.38	124.79	2	J
	35	27/07/1991	46.87	124.88	1	I
	36	20/09/1992	46.82	125.58	2	I
	37	20/09/1992	46.82	125.50	1	I
	38	24/07/1994	46.67	126.12	3	K
	39	25/07/1994	46.18	128.62	2	K
	40	26/07/1994	45.08	130.38	2	K
	41	26/07/1994	45.23	130.03	2	K
	42	26/07/1994	45.22	131.00	4	K
	43	31/07/1994	46.50	127.42	1	K
	44	02/08/1994	52.38	132.48	4	K
	45	27/09/1994	49.65	128.58	2	K
	46	21/07/1996	45.85	129.70	2	K
	47	22/07/1996	45.87	129.71	2	K
	48	24/07/1996	45.32	125.65	2	K
	49	02/09/1996	46.05	125.09	1	K
	50	03/09/1996	51.00	130.69	2	B
	51	07/09/1996	47.40	126.86	1	K

Species	No. on Figure	Date (dd/mm/yyyy)	Latitude (° N)	Longitude (° W)	No. Observed (age[1])	Source[2]
	52	07/09/1996	46.89	126.81	1	K
	53	08/09/1996	45.51	127.97	1	K
	54	09/09/1996	47.42	126.86	1	J
	55	09/09/1996	47.03	126.82	1	J
	56	21/09/1996	46.87	125.37	2	I
	57	06/09/1997	46.90	124.85	2	I
	58	25/10/1997	48.43	126.02	1	B
	59	13/09/1998	46.90	124.87	2	I
	60	15/09/1998	49.04	126.28	2	L
	61	14/08/1999	46.88	125.00	2	I
	62	09/10/1999	46.87	124.88	1	I
	63	08/08/2000	48.58	126.17	2	B
	64	08/08/2000	52.46	132.71	2	B
	65	26/08/2000	46.88	125.02	1	I
	65	06/09/2000	48.70	127.26	2	B
	66	06/09/2000	48.73	127.50	4	B
	67	18/09/2000	51.00	131.82	2	B
	68	04/08/2001	46.88	125.03	2	I
	69	13/08/2001	45.95	125.49	2	K
	70	27/08/2001	48.58	126.17	3	B
	71	04/09/2001	47.68	126.75	2	L
	72	04/09/2001	47.67	126.65	2	K
	73	05/09/2001	47.72	126.09	4	L
	74	05/09/2001	47.55	125.98	4	L
	75	05/09/2001	47.38	125.52	2	L
	76	05/09/2001	47.79	126.06	2	K
	77	05/09/2001	47.54	125.94	2	K
	78	05/09/2001	47.38	125.41	2	K
	79	06/09/2001	46.59	124.91	2	K
	80	07/09/2001	45.89	125.19	2	K
	81	07/09/2001	46.62	124.91	2	L
	82	29/09/2001	46.88	125.00	1	I
	83	05/09/2002	46.88	124.93	2	I
	84	08/09/2002	51.67	130.85	2	B
	85	07/10/2002	46.92	124.20	2	I
	86	19/07/2003	46.80	125.08	2	I
	87	01/09/2003	48.82	128.55	2	B
	88	08/09/2003	46.90	125.03	2	I
	89	10/07/2004	46.87	124.88	2	I
	90	10/07/2004	46.87	124.77	4	I
	91	21/08/2004	46.85	124.95	2	I
	92	28/08/2004	46.90	124.93	2	I
	93	25/09/2004	49.03	126.32	2	L
	94	25/06/2005	46.82	124.93	2	I
	95	06/08/2005	46.85	124.94	2	I
	96	29/08/2005	51.30	132.01	1	B
	97	29/08/2005	51.52	132.11	1	B
	98	08/07/2006	46.93	125.00	1	I
	99	15/07/2006	46.90	124.93	2	I
	100	20/07/2006	48.85	128.20	2	B
	101	20/07/2006	48.88	128.19	2	B

Species	No. on Figure	Date (dd/mm/yyyy)	Latitude (° N)	Longitude (° W)	No. Observed (age[1])	Source[2]
	102	06/08/2006	46.80	124.82	2	I
	103	24/08/2006	46.82	124.88	2	I
	104	10/09/2006	51.47	134.27	2	B
	105	30/09/2006	46.53	124.54	1	I
Parakeet Auklet (fig. 47)						
	1	27/09/1982	51.38	133.73	1	G
	2	28/09/1982	51.77	130.95	1	G
	3	16/09/1983	50.78	130.38	1	G
	4	14/10/1984	53.40	132.95	1	G
	5	14/10/1984	53.72	133.28	1	G
	6	14/10/1984	53.77	133.37	1	G
	7	15/10/1984	54.35	133.02	1	G
	8	27/10/1988	48.33	127.17	1	G
	9	29/05/1989	49.47	136.77	1	G
* = position estimated	10	13/05/1993	52.84*	131.58*	3	M
	11	08/06/1995	52.73	132.61	1	B
	12	14/02/1997	48.67	126.87	1	B
	13	14/02/1997	48.66	126.79	4	B
	14	14/02/1997	48.64	126.59	1	B
	15	26/02/1997	48.83	128.90	1	B
	16	22/02/1998	49.09	132.27	1	B
	17	09/02/1999	48.58	125.73	1	B
	18	08/02/2001	48.84	129.00	2	B
	19	06/10/2002	52.73	139.69	1	B
	20	17/02/2003	48.76	127.87	1	B
	21	01/04/2003	48.96	126.47	1	B
	22	01/04/2003	48.75	125.89	4	B
	23	27/02/2004	48.67	127.73	1	B
	24	04/04/2004	52.85	143.17	1	B
	25	06/02/2006	48.91	129.82	1	B
	26	03/10/2006	51.19	145.01	1	B
	27	19/02/2007	51.24	133.01	2	B
* = position estimated	28	14/12/2007	48.52*	124.44*	1	N
Unconfirmed/Hypothetical Rare Species						
Dark-rumped Petrel (fig. 51)	1	23/08/1996	49.57	138.64	1	B
	2	11/06/1999	50.03	145.33	1	B
	3	07/07/2002	49.86	145.02	1	B
	4	07/07/2002	50.08	145.29	1	B
	5	10/07/2002	50.31	144.81	1	B
	6	31/08/2002	49.84	142.55	1	B
	7	31/08/2002	49.86	142.76	1	B
	8	31/08/2002	49.91	143.10	1	B
	9	04/09/2002	49.83	145.10	1	B
	10	04/09/2002	49.99	144.97	1	B
	11	05/09/2002	50.60	142.71	1	B
	12	08/09/2003	50.30	141.96	1	B
	13	25/08/2004	49.77	141.73	1	B
	14	25/08/2004	49.81	142.31	1	B
	15	28/08/2004	51.03	141.08	1	B

Species	No. on Figure	Date (dd/mm/yyyy)	Latitude (° N)	Longitude (° W)	No. Observed (age[1])	Source[2]
	16	24/08/2005	50.00	148.09	1	B
	17	26/08/2005	52.47	141.69	1	B
	18	19/09/2005	49.57	142.02	1	B
	19	19/09/2005	49.79	142.53	1	B
	20	19/09/2005	49.81	142.58	1	B
	21	19/09/2005	49.84	142.63	1	B
	22	19/09/2005	50.18	143.51	1	B
	23	19/09/2005	50.31	143.84	1	B
	24	20/09/2005	51.52	148.21	1	B
	25	06/07/2007	53.13	146.74	1	B
	26	20/08/2007	49.49	137.66	1	B
	27	20/08/2007	49.53	138.08	1	B
Cook's Petrel (fig. 52)	1	17/07/1993	54.10	146.15	1	B
	2	18/06/1999	49.52	138.00	1	B
# = outside study area		15/02/2002 #	47.55	150.58	1	E
	3	6/10/2002	52.40	137.94	1	B
Herald Petrel (fig. 52)	4	04/04/2004	52.40	140.39	1	B
Solander's Petrel (fig. 52)	5	17/06/1997	50.78	145.00	1	B
Streaked Shearwater (fig. 53)	1	06/07/2002	49.53	145.46	1	B
Manx Shearwater (fig. 53)		18/07/1993 #	54.73	155.09	1	B
# = outside study area		19/07/1993 #	54.87	163.19	1	B
	2	18/05/1998	50.75	129.52	1	B
	3	06/06/1998	52.69	130.70	1	O
	4	04/05/2002	50.96	128.97	1	B
	5	16/06/2004	50.84	128.43	1	B
* = position estimated	6	08/08/2004	48.30*	123.43*	1	P
* = position estimated	7	02/06/2005	48.64*	124.82*	1	P
	8	02/07/2005	51.58	128.71	1	Q
	9	10/07/2006	51.62	128.72	1	Q
Black-vented Shearwater (fig. 53)	10	17/07/1976	52.85	136.02	1	R
	11	17/09/1982	48.62	126.08	1	G
	12	18/09/1982	49.10	132.40	1	G
	13	23/09/1982	50.00	145.00	1	G
	14	28/09/1982	50.57	128.80	1	G
	15	29/09/1982	49.03	126.07	1	G
	16	26/08/1983	48.92	126.28	1	G
	17	14/10/1984	53.05	132.60	1	G
	18	09/08/1988	50.03	127.78	1	G
	19	26/10/1988	48.23	125.82	1	G
	20	23/06/1999	48.60	128.03	1	B
Iceland Gull (fig. 54)	1	27/05/1989	48.78	125.87	1	G
Slaty-backed Gull (fig. 54)	2	20/10/1986	48.5	124.68	1	G
Aleutian Tern (fig. 54)	3	23/05/1996	49.60	142.10	1	B
* = position estimated	4	07/06/1997	48.97*	130.67*	1	B

1 Age categories (Short-tailed Albatross only): J = juvenile, I = immature, S = subadult, A = adult, na = age not indicated

2 Sources as follows:

A. North Pacific Pelagic Seabird Database (2005)
B. This study (including unpublished Canadian Wildlife Service data)
C. Captain J. Anderson (retired), Canadian Coast Guard, pers. comm.
D. International Pacific Halibut Commission: annual stock assessment survey data
E. Continuous Plankton Survey Project (Sir Alistair Hardy Foundation for Ocean Science, Point Reyes Bird Observatory Conservation Science and Canadian Wildlife Service/Environment Canada)
F. K.G. Cruickshank (pers. comm.)
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H. Sanger (1973)
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J. L. Spear/D. Ainley: data were collected aboard vessels provided by the National Science Foundation and National Oceanic and Atmospheric Administration (Eastern Pacific Ocean Climate Study program) with funding to Spear/Ainley by NSF grants OCE8515637, OCE8911125 and OPP-9526435; and National Geographic Society grants 3321-86 and 4106-89
K. L. Ballance/M. Force: data from OR, CA, and WA Marine Mammal and Ecosystem Assessment Surveys; and the Aleutian Islands Marine Mammal and Ecosystem Assessment Survey; these two programs were conducted by the Protected Resource Division of the National Oceanic and Atmospheric Administration Fisheries (La Jolla, CA) *http://swfsc.noaa.gov/prd-ecology.aspx*
L. R. Palm: data collection funded by Strawberry Isle Marine Research Society
M. Sirois and Butler 1994
N. R. Toochin (pers. comm.)
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